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ABSTRACT

Methods of preserving, protecting, and keeping buildings, grounds, and equipment in a satisfactory operating condition are described. Detailed information is presented concerning the maintenance of items classified as either interior or exterior facilities. The problems of fire prevention and safety are discussed, including the development of a good fire prevention program. The establishment of centralized school service centers is treated as an important and vital phase of school maintenance. Suggestions are made for providing acceptable and standardized maintenance procedures and techniques. (FS)

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MAINTENANCE OF SCHOOL FACILITIES

Prepared by a
Special Committee under
the direction
of
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Issued by

STATE DEPARTMENT OF PUBLIC EDUCATION
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ACKNOWLEDGMENTS

School plant maintenance is an important phase of the school program. Administrators and maintenance personnel have been aware of a need for the preparation of a handbook for the purpose of presenting important guides to assist in preserving, protecting, and keeping buildings, grounds, and equipment in a satisfactory operating condition.

A committee of school administrators was assigned the responsibility of preparing a school maintenance and operation handbook. The scope of the problem and availability of data necessitated the preparation of two bulletins, the first concerned with maintenance techniques and the second concerned with operational procedures. Hence, two sub-committees were designated and assigned the responsibility of preparing separate guides for each phase of the program.

The first of these two guides has been prepared and the State Department of Education is indebted to the members of the sub-committee who cooperated in the preparation of the publication concerned with school maintenance.

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CHAPTER I

INTRODUCTION

School plant operation and maintenance, two closely related areas of school plant management, constitute one of a number of complex problems which confront public school boards. An essential factor in efficient school administration is a well organized and properly functioning service for the operation and maintenance of the school plant. Operation includes those day to day services and activities which are necessary to keep the physical plant open and in a usable condtion.[1] Meanwhile, Finchum[2] has defined maintenance as consisting of those services, activities, and procedures which are concerned with preserving, protecting, and keeping buildings, grounds, and equipment in a satisfactory state of repair and covering a wide range of activities including some repairs, replacements, renovations, and adjustments.

Problem

In the one room school building the teacher served in the maintenance phase as well as in the instructional phase of the school program. Little if any significance was attached to maintenance except daily routine tasks performed by the teacher during the recess or noon periods. However, in the modern consolidated school building, with up-to-date systems of heating and ventilation, sanitary drinking fountains, electrical systems, and modern plumbing facilities, school maintenance has acquired greater significance in the over-all school program. Formerly, plant maintenance occupied a very small portion of the school administrator's time and effort. Today, this important function demands organized planning and adequate financing.

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[1] R. N. Finchum, Organizing the Maintenance Program. U. S. Office of Education (Washington, D. C.: U. S. Government Printing Office, 1960), p. 1.

[2] Ibid., p. 1.

The responsibilities of a sound school maintenance program are numerous and varied. Publications and reports analyzing limited phases of the maintenance program have been made available to appropriate personnel; however, a composite report prepared for the purpose of indicating proper procedures and techniques in performing all required maintenance functions has been needed in the public schools for several years. Consequently, it was the purpose of this committee to prepare a guide, for school maintenance personnel, setting forth standardized procedures and techniques utilized in preserving, protecting, and keeping buildings, grounds, and equipment in a satisfactory condition.

Importance of Maintenance

In 1960, the value of buildings, sites, and equipment for all public elementary and secondary schools in Louisiana exceeded a half billion dollars. Furthermore, the present annual rate of increase of value indicates that in the years ahead, school property investments will be approaching the billion dollar mark.

In order for these existing facilities and other property investments which may be made in the future to function in a satisfactory and efficient manner, adequate maintenance must be provided. Too, a properly organized school maintenance program is essential to protect the long term investments which parish and city schools must assume in providing facilities for children and youth.

Expenditures for maintenance of the plant have always represented an important item of the budget of parish and city school boards. Various items concerned with the repair and upkeep of buildings and grounds in addition to salaries of carpenters, plumbers, electricians, and painters are included in maintenance expenditures. For many years school administrators have recognized the folly of constructing outstanding school facilities while neglecting to provide adequate maintenance programs to protect these investments.

Maintenance Costs

Table I indicates the per cent of expenditures of the current operation budget allocated for school maintenance purposes by the sixty-seven parish and city school boards in Louisiana for the post-war period 1946-1960.

Table I

RATIO OF EXPENDITURES FOR SCHOOL MAINTENANCE AND CURRENT OPERATION[3]

1946-1960

Session	Expenditures Current Operation	 Maintenance	Ratio
1945-46	$ 36,122,299	$1,493,330	4.13
1947-48	53,503,495	2,610,581	4.88
1949-50	85,758,962	3,803,165	4.43
1951-52	96,821,254	5,204,149	5.38
1953-54	112,533,295	5,634,068	5.01
1955-56	137,336,056	6,965,518	5.07
1957-58	180,738,351	6,096,085	3.38
1959-60	207,738,351	7,293,657	3.51

Since 1946, expenditures allocated for maintenance of school plant facilities range from a maximum of 5.38 per cent to a minimum of 3.38 per cent of all expenditures for major functions. Since 1958, expenditures for maintenance purposes have been less than four per cent. This percentage is less than the reputed five per cent that has been generally accepted by school authorities as being the amount necessary to support an adequate maintenance program.[4] For a new school building it has been suggested that from one-half to one per cent of the total plant cost should be allocated each year for its maintenance.[5] For older buildings which have been properly maintained from year to year, some authorities suggest that from one to two per cent of the current replacement cost of a school plant should be budgeted for each year of maintenance.[6]

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[3] Louisiana State Department of Education, Annual Report of the State Department of Education for 1959-60. (Baton Rouge: Thomas H. Moran and Sons Publishing Co., 1961), pp. 102-193.

[4] R. N. Finchum, op. cit., p. 2.

Although the recommended minimum expenditure for school plant maintenance is five per cent of the total annual opeating budget for the school district, reported data reveals that basic school units spend less for this purpose. Finchum, in preparing material on the organization of the maintenance program, stated:

> A review of the biennial reports in expenditures for all full-time public elementary and secondary day schools in the continental United States from 1947-48 through 1955-56 reveals that in only one geographical section of the country -- the North Central -- have expenditures for maintenance equaled or exceeded recommended amounts, and in this case, for only two of the five years.[7]

These figures are cited to give an approximation of the relative over-all cost of the maintenance program. The actual cost of the maintenance program is based on factors entirely independent of the over-all school budget. The most important factor is the quality of the maintenance. Assuming, however, that quality is held at a uniform level, then maintenance costs are influenced by several factors: (1) the amount and type of land in the system; (2) the number, size, type, age, and condition of the buildings in the system; (3) the presence of special maintenance saving features in the buildings -- the quantity, type, age, and condition of the furniture; (4) the number and salary level of maintenance personnel; and (5) the degree of utilization of labor-saving organization and equipment.

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[5] R. N. Finchum, op. cit., p. 2.
[6] R. N. Finchum, op. cit., p. 3.
[7] R. N. Finchum, op. cit., p. 3.

An increase in teachers' salaries would have a great effect on the budget, but none on the cost of maintenance. The higher cost school buildings are usually cheaper to maintain than the lower cost buildings. Therefore, the cost of the maintenance program should be based not on percentage of the gross budget, but on the actual cost of operating an adequate maintenance program in an efficient manner.

Gradually, parish and city school boards have been required to absorb increased costs in other major functions from funds that normally would have been budgeted for maintenance purposes. While it is true that many of these diverted funds have been allocated to programs designated by legislative authority, it remains the responsibility of local school boards to assure that investments totaling millions of dollars are not allowed to deteriorate by failure to provide a sound maintenance program.

At present parish and city school boards are authorized to levy a parish-wide maintenance tax of seven mills. Paragraphs 4 and 5 of

Section 15, of Article XII of the Constitution of Louisiana provide:

> Fourth: Maximum millage. The maximum of mills of special annual ad valorem maintenance taxes for giving additional support for the current operation of public schools heretofore authorized by Section 10 of Article X of this Constitution, which shall be hereafter allowable, shall in no case exceed seven (7) mills. (Amended Acts 1956, No. 629, adopted Nov. 6, 1956.)
>
> Fifth: Local special tax leeway. The right of local special tax leeway for maintenance, upon vote of the people as provided for by law, to the extent of seven (7) mills on the dollar of assessed valuation in any parish shall be and is preserved and shall not be denied. (Amended Acts 1956, No. 629, adopted November 6, 1956.)[8]

A large percentage of the basic school administration units in Louisiana have utilized this authorization, and as a result, adequate maintenance programs have been organized. However, it is important that in the future such programs be continued in order to protect property investments.

Finchum has stated that in order to stimulate public interest in and develop a deep concern for the significance of school plant maintenance, it seems appropriate to suggest that school officials might perform an essential service by publicizing the advantages inherent in a long-range, well-planned, adequately-financed maintenance program for the school district.[9]

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[8] West's Louisiana Statutes Annotated, Louisiana Constitution Supplement. (St. Paul: West Publishing Co., 1961), p. 85.

[9] R. N. Finchum, op. cit., p. 7.

Maintenance Aims

The over-all objective of maintenance is to keep school facilities in such condition that they will meet the requirements of the educational program. More specifically, maintenance aims include those activities, services, and procedures which help to (1) promote health and safety, (2) provide operating economies, (3) prevent time loss, (4) preserve property values, (5) retard deterioration, (6) prevent obsolescence, and (7) develop community pride.[10]

Health and Safety. Insanitary conditions create many health problems. Respiratory diseases are spread by dust and germ-laden air, digestive disorders are often brought on by the consumption of food which has been improperly stored, prepared, handled, or served; many other types of communicable diseases and infections may be spread by insects and rodents which are often harbored in unprotected storage areas and on neglected campus areas; and many other health hazards may be created by insanitary, foul-smelling toilet areas. Classrooms that are underheated or overheated and are poorly ventilated do not promote good health. Impaired eyesight and other visual difficulties are frequently caused by poor or improperly controlled artificial and natural lighting. Certain nervous disorders and auditory problems may be brought about by unsatisfactory sonic conditions. The maintenance program and the school plant planning program, if designed to promote health, will give due consideration to these and other health factors.[11]

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[10] R. N. Finchum, op. cit., p. 7.

In addition to providing a school environment which is conducive to good health and to favorable conditions for learning, officials are obligated to maintain safe school facilities. Parents, children, and employees have every right to demand safe buildings, grounds, and equipment. School safety, an all-inclusive term, covers such risks as fire, mechanical, electrical, boilerroom, and maintenance hazards.[12]

Maintenance of school facilities is closely related to the effectiveness of the school. Some examples of maintenance hazards include highly waxed and polished floors and stair treads, failure to change air filters because of the expense involved, storage of combustibles in spaces not designed for such materials, the use of attic space for storage, insufficient illumination for stairwells and in other areas where falls may occur, improper layout and surfacing of playground areas, poorly planned access roads and service drives for the premises, and the use of flammable curtains in auditoriums. Proper maintenance can either remove or minimize these hazards.[13]

Economy of Operation. In general, school plant operating economies seem to fall into three categories: labor, utilities, and supplies and equipment.

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[11] R. N. Finchum, op. cit., p. 7.
[12] Ibid., p. 8.
[13] Ibid., p. 9.

In many buildings, particularly in older ones, such items as convenient service sinks, adequate and convenient storage for custodial supplies and equipment, suitably located electric service outlets, and hose bibs for both hot and cold water at strategic locations have been overlooked. These conditions can generally be corrected by the maintenance department so that the time consumed by custodians in running to remote parts of the building obtaining tools and supplies and later replacing them can be cut to a minimum.[14]

In the category of utilities, proper maintenance may affect economies in the cost of water, fuel, and electricity. For example, a water faucet with a steady drip will waste about 9,000 gallons of water each year; a faucet with a steady stream one-eight inch in diameter will waste 9,000 gallons of water in three days or more than a million gallons a year. In addition, if these faucets are on hot water lines, there is a waste of fuel to heat the water. Replacement of gaskets, or even the faucets themselves, is an inexpensive maintenance procedure which may save many dollars during the course of a school year.[15]

Electrical services often become expensive because of wasted current. Inefficient fixtures cause current waste; old, inefficient electric motors consume more current and deliver less power than new motors. Color of ceilings affect illumination levels. If ceilings do not have the proper reflectance factor, the efficiency of electric lights is decreased. In addition, electric lights often replace natural illumination because outside windows are not clean. This applies not only to window glass but also to glass fixtures used in connection with electric lights. An adequate maintenance program will provide for the replacement of inefficient fixtures and motors, correct ceiling conditions, and keep windows and light fixtures clean, thus eliminating much waste in the use of electric current.[16]

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[14] Ibid., p. 10.
[15] Ibid., p. 11.

Other school plant operating ecomomies may be effected through the selection, purchase, and use of maintenance tools and equipment. Such economies may be realized through greater efficiency in work standards, improved quality of results achieved, decreased quantity of materials used, and an improved morale among workers whose feeling of achievement will be much higher than that of personnel without adequate equipment. For example, the purchase of an electric scrubbing-buffing machine and a wet-dry vacuum machine may save enough custodial man-hours during one year to more than pay for the equipment. At the same time, better cleaning and polishing results will be shown, and the operators will have more pride in their accomplishment. The installation of pit receptacles at each outside door in school buildings where the grounds are muddy, or likely to become so, may cost a few extra dollars but will save endless hours in floor cleaning operations.[17]

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[16] Ibid., p. 11.

Time Loss. Another purpose of maintenance is to prevent plant shutdowns and time losses. This objective may be achieved through a program of "preventive maintenance," a plan whose concept is similar to that of "preventive medicine." It operates on the principle that it is important to correct minor defects before "epidemic" proportions are reached.[18]

In years prior to the advent of complicated mechanical and service features of school buildings, breakdowns necessitating the closing of schools were rare; but as these features have been added, there is greater opportunity for serious mechanical failures which make it necessary to close schools until repairs are made. Thermostatically controlled steam supply valves, electronically controlled motors for heating plants and ventilating systems, and in some instances sanitary and other service systems involving hydraulics are some examples of the complicated mechanical and service features of many present-day school buildings.[19]

Although emergencies may arise in situations where preventive maintenance is practiced, such occasions are far less frequent when periodic checks of equipment, followed by replacement of defective parts or faulty items, are made. Such periodic inspection makes it possible for the maintenance department to make repairs long in advance of actual breakdowns, thus averting plant shutdowns and time losses or discomfort to occupants.

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[17] Ibid., p. 11-12.
[18] Ibid., p. 12.
[19] Ibid., p. 12.

In actual practice, it has been found that such repair and corrections can be made during the summer months when school buildings are unoccupied. This procedure is not only practical but also economical.[20]

Property Values. In most communities, school properties represent a financial investment which has necessitated heavy local tax levies and often maximum local effort over a period of several years. Preservation of these property values is an evident aim of maintenance. Adequate school plant operation and maintenance retard deterioration, reduce fire hazards, decrease the need for extensive periodic rehabilitation, and extend the useful lives of buildings and equipment, thus preserving the community's investment in such properties.[21]

Obsolescence. Today, there are many communities across the country in which a number of school buildings no longer meet the housing requirements of the educational program. In some instances, these communities have either reached or approached the maximum limit of their bonding capacity, and can no longer provide the necessary funds for new school construction. These and other economy-minded communities may be able to decrease their school housing problems by improving conditions in existing buildings. Many of these lacking some of the elements essential to a good environment for learning, but suitably located with respect to school population, are too sound structurally to be abandoned.[23]

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[20] Ibid., p. 12.
[21] Ibid., p. 12-13.

Such buildings are generally classified as obsolete, yet in most instances, they can be improved to adequately meet today's educational needs in their particular districts. As a maintenance procedure, these improvements can usually be accomplished through a process of modernization, rehabilitation, or remodeling. If it is decided that these obsolete buildings can remain in use for educational purposes, a complete job of rehabilitation -- sometimes referred to as "Comprehensive Renovation" -- should be done.[24]

Community Pride. Promoting community pride in school facilities through a program of maintenance has greater significance than just "pleasing the public." School officials are well aware of the fact that a clean, well-kept school plant not only contributes to the health, happiness, and character development of the children, but also promotes a favorable community attitude toward the school, develops respect for school property, and thus becomes a factor in its preservation. School principals often assert that inadequate school plant maintenance frequently breeds pupil contempt for the property which is often expressed through misuse of washrooms, littering of premises, and defacing walls, furniture, and equipment, as well as other forms of vandalism. On the other hand, good maintenance generally, but not always, creates an atmosphere where just the opposite is true.[25]

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[23] Ibid., p. 13.
[24] Ibid., p. 13-14.

Furthermore, adequate care of valuable school property has implications for public relations as well as for fiscal management. In most communities, it is pleasing to the public to know that officials have preserved public school property through efficient, economical management procedures. This public attitude is often demonstrated by the reasonable financial support accorded the school and by the pride with which its facilities are shown to outsiders.[26]

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[25] Ibid., p. 15.
[26] Ibid., p. 15.

CHAPTER II

MAINTENANCE OF EXTERIOR FACILITIES

In the organization of a school maintenance program it is generally recognized that exterior facilities as well as interior facilities must be included if the program is to be efficient and successful. Normally considered as exterior facilities are such items as school grounds, building foundations, walls, windows and curtain walls, and roofs. Meanwhile, such items as floors, plumbing system, electrical apparatus, heat, and air conditioning, hardware, and furniture are classified as interior facilities. Only through the detailed consideration of both areas may a complete maintenance program be organized and operated.

A. GROUNDS

Site Selection. In selecting a location for a school, it is important that the site be selected and purchased well in advance of actual school building construction. The site should facilitate and reflect the educational program to be provided. It should be adequate enough for various types of play, recreation, camping, nature study, gardening, conservation activities, and other outdoor experiences which may be included in the program. It should be large enough to accommodate necessary buildings, provide ample space for outdoor instructional and recreational activities, and furnish plenty of area for parking. It is generally recognized that a minimum of five acres for any elementary school plus and an additional acre for each 100 pupils enrolled is needed for an adequate site. For a high school site, a minimum of ten acres plus and an additional acre for each 100 pupils enrolled is recommended.

The site should have a satisfactory subsoil, good elevation, a desirable contour, and be conveniently located.

Selection of Grasses. It is important to select the proper grass or combination of grasses to attain good results. Today the successful turf is not a combination of four or five different grasses, but a concentration of only one, or at most two, predominant grasses. Some of the more common grasses found in Louisiana are these:

Bermuda Grass. Bermuda grass is a long-lived perennial with a spreading habit of growth. It propagates by runners, underground rootstocks, and seed. It grows well on almost any soil that is fertile and not too wet. Because the seeds are small and light a well-prepared seedbed is desirable. This grass is a common lawn grass, but it is not considered a good grass to use except for specific purposes, such as erosion control, slope treatment, playgrounds, golf courses, and athletic fields. Desirable qualities of Bermuda grass are its hardiness drought resistance, and its adaptability to a wide range of soils and soil reactions.

St. Augustine Grass. This is an extensively creeping, rather coarse glabrous perennial that produces stolons with long internodes and branches that are short, rather leafy, and flat. St. Augustine grass thrives in shaded areas and is especially adapted for lawns. It is naturally a seashore plant and withstands salt spray. Because it has no seed available, rooted runners must be used to start a new planting.

Blue Grass. The bluegrasses are generally distinguished by small, awnless spikelets. They are useful for pasturage, hay, and lawn. Generally, these grasses should be planted in the fall, when there is more moisture and temperature conditions are better than in summer. Where bluegrass is used for lawns, nitrogen is required to promote vigorous growth and to maintain a desirable dark green color. For best growth, phosphorous, potassium, and nitrogen are all essential. Lime is not essential unless the soil is deficient in calcium.

Maintenance Practices. In providing proper care of lawn grasses, authorities generally recognize the following suggestions:

Watering. All watering should be done in the afternoon or night. During droughts, the lawn should be soaked at least twice a week.

Top-dressing. A well-shredded compost of organic materials should be spread on the lawn at least once a year. The organic material should be treated with chemicals to kill insects, diseases, and weeds before being spread.

Mowing. One of the major reasons for failures in turf is close clipping. The mower should be set at approximately two inches.

Control of Pests and Diseases. There are several turf pests and diseases which are harmful, in varying degrees, to grass. The following fungus diseases fall in this category: leafspot, brown patch, dollarspot, mildew, and damping-off, to name a few. Turf pests harmful to grass are mushrooms, white grubs, Japanese beetles, cutworms, and chinch bugs. All of the above mentioned diseases and pests can be controlled by methods known to a county agent or a vocational agriculture teacher.

Planting and Care of Trees. Adequate preparation of the soil before planting trees reduces future maintenance problems. Topsoil for individual trees will vary with the size of the tree and the size of the ball. The soil around trees is cultivated to control and eliminate weeds, but this work does not seem to have any other value in stimulating plant growth. With small and newly planted trees, cultivation may be the most convenient way to insure a good start, especially for the first two or three years. Some organic materials that can be purchased are prepared stock-yard sheep and cattle manure, tankage, dried blood, fish scraps, sewage sludge, cottonseed meal, soybean meal, ground bone, steamed bone, and many brands of peatmoss and humus.

Time to Plant. The best time to plant trees is in the fall, preferably between November 1 to January 1. In selecting the site or sites in which trees are to be planted, it is important to locate the planting areas at safe distances from any buildings.

Pruning. Prune trees at the time of planting to insure well-developed framework and to reduce top growth to compensate for roots lost in moving. Do not cut back vigorous trees that were thoroughly thinned out at the time of planting. Cutting back the branches removes a year or more of growth and gives trees a formal shape until the condition is outgrown.

Shade Trees. Some fast-growing trees are ash, elm, sycamores, and cottonwoods. Slower-growing shade trees are hackberry, swamp oak, red oak, gum, and live oak.

Planting and Care for Grounds. There are many shrubs that could be listed as desirable for school grounds. The evergreen varieties are very durable and desirable. Rose bushes are very attractive in beds and azaleas are beautiful, abundant bloomers. It is recommended that advice be secured from nursery people and landscapers when a selection of trees and shrubs is made.

Disease and Insect Control. The control of insects and disease of trees and shrubs is becoming an ever-increasing problem. Many new chemicals are proving effective, and many of the old standby formulas are still good. The control of diseases in trees and shrubs is based largely on eradication and protection. For example, collecting and burning fallen leaves from diseased plants will eliminate one source of trouble. Pruning infested branches and burning them also removes a source of subsequent infestations. Spraying with dormant sprays at the point of infestation is another method of control.

Spraying is a successful way of combating disease. Sprays must be applied at the right time, used as a fine mist to cover plant, and composed of proper ingredients. The most common sprays are copper, sulphur, and a combination of different chemicals.

For control of insects there are many kinds of insecticides on the market. One of the most common is composed of nicotine, pyrethrin, rotenone, soap, oil, or lime sulphur. Chlorodane is also recommended, but it must be used with care because of its poisonous nature.

Pruning. Shrubs pruned when planted recover and regain natural shape more quickly than unpruned plants. In general, approximately one-third of the top growth should be pruned.

Equipment. The selection, use, and maintenance of all types of ground care equipment are important. Good equipment, a well-rounded supply of materials, and an efficient maintenance program determine the difference between economical and efficiently operated programs and costly and inefficiently operated programs. Preventive maintenance is very important in reducing the number and extent of repairs.

There is a wide variety of equipment on the market which is designed to speed the job of ground maintenance. The following list and descriptions give some indication of equipment that can be used in the schools.

Power Mowers. A wide selection of power mowers is available. This equipment usually ranges from small 18-inch mowers to large tractor-drawn rotary or gang mowers. Practically all mowers are rotary, sickle bar, or reel type, and it is a matter of judgment which type is best suited to the particular use.

Generally speaking, the rotary mower is used and built for rough and heavy work. It will cut weeds and coarse grass, whereas the reel-type mowers would hardly suffice. The sickle bar mower is generally used on highways shoulders and slopes, whereas the reel type, single or gang, is used principally on lawns and parks. A hand power scythe is ideal for use on steep side slopes. This mower is a standard sickle bar power unit with a bicycle wheel attachment to maintain balance on the slope.

Other Tools. Power saws may be needed when the campus has enough trees and shrubs. In addition, there are many hand tools that are necessary for a good ground maintenance program. These are axes, picks, shovels, rakes, saws, hammers, and others too numerous to mention.

B. BUILDING FOUNDATIONS

Introduction. In order to provide principals and maintenance personnel with a better understanding of the problem involved, certain basic factors should be considered.

Building structures in general, including school buildings, are supported by one of several types of foundations. These foundations may be divided into three general types:

1. Footing foundations
2. Mat foundations including floating slabs and other types of floating foundations
3. Pile foundations

All foundation structures which support the buildings are, in turn, supported by the soil beneath. The studies of soils and of structures are, in effect, separate sciences. However, the failure of either soil or foundation structures will cause consequent failure of the supported building.

Causes of Failure. Since all of the above mentioned foundations are supported by the soil, school maintenance personnel must recognize that changes in soil conditions may cause or induce failure in the foundation structure of the building. The most common undesirable change in the soil structure is a change in the water level. This condition may lead to rotting of untreated wood pilings or differential shrinking of the soil which would cause uneven settlement of the building. Change in water level of the soil may be traced to these most common causes:

1. Location of drainage ditches near a previously established structure
2. Location of water and sewer or other pipe lines near the foundation of the building
3. Major excavations in the immediate vicinity of the building
4. Installation of large area drainage systems which would lower the water table
5. Improper drainage around the perimeter of the building softening the ground around and under the foundation.

School personnel should be alert to any of the above activities or installations which may result in building damage. In checking building foundations, it is frequently desirable to consult a competent structural, foundation, or civil engineer.

Evidences of Failure. School personnel should be alert to any of the following evidences which may indicate foundation or soil failure:

1. Parapet walls -- vertical cracks or cracks which zigzag through the mortar joints
2. Masonry mortar joints which were straight and have deviated

from a straight line

3. Cracks in the exterior masonry walls of the building -- both vertical cracks and zigzag cracks which follow the mortar joints
4. Warping, changes in elevation of floors, or any other indication of differential settlement or movement of the building.

Ordinarily, small hairline cracks in parapets or wall surfaces of masonry buildings are a condition which is expected in buildings and are not indicative of any failure of consequence. However, a multiplicity of hairline cracks occurring at any one time would indicate that the area involved should be carefully watched for deterioration.

It is suggested that all cracks of consequence be marked and dated when discovered in parapet or other masonry walls. By reinspection at a later date, maintenance personnel will be able to observe and note on a check list the increase in length and width of the cracks under observation. The object of the above observation on cracks is to determine any progressive movement or distortion of the building and the time over which such movement or distortion has occurred.

Some helpful suggestions may be followed in examining a building. Cracks in parapet walls and in other masonry walls can be noted by inspection or visual examination. Crooked or warping masonry mortar joints may be detected by standing at one of the building corners and sighting along the edge of the mortar joint. Warping of floors or differential settlement may be discovered by stretching a string line in several directions across the surface of the floor.

It should be borne in mind that school personnel can prevent some of the above mentioned failures by (1) preventing the installation of large water lines, drain lines, or deep excavations in close proximity to the buildings; (2) consulting a civil or foundation engineer before general area drainage is to be installed; and (3) consulting a competent foundation or civil engineer as soon as any of the above mentioned evidences of foundation failure are noted.

Finally, good records should be maintained by the school or school district on all structures. These records should include two sets of the original blue prints and specifications for the structure as well as copies of engineering studies performed on the building since construction.

Included in such engineering studies should be any soil analysis or other pre-construction foundation studies available. One set of the original blue prints and specifications should be designated to remain in the office where the building file is kept and should not be allowed to leave the area. Such a file will enable new personnel to avoid duplicating expenditures for consultation and may reduce the cost and increase the effectiveness of consultation when such becomes necessary.

C. WALLS AND CEILINGS

To preserve the water-tight integrity of a building requires periodic inspection and routine maintenance. The major portion of the problems occur because of building movement due to expansion or contraction and the wearing away of materials originally used to insure a water-tight building. In addition, soil structure, and poor structure foundation are common causes of problems which may arise.

Assuming that no structural failure has occurred which has resulted in a pronounced shifting of the building, the following points should be periodically checked.

Coping. Expansion and contraction causes the rupture of joints which need to be re-soldered, re-riveted, or re-caulked depending on the type of material originally employed. The same type of problem exists with stone or ceramic materials as with metal. The re-pointing of joints is a seasonal job.

Roof Drains. 1. Interior. Clogged roof drains permit water to accumulate. When this situation occurs, leaks develop along the upper flashing line and through the masonry causing both interior and exterior damage to the walls. Periodic roof drain inspections and cleaning will prevent this problem from starting.

2. Exterior. Gutters and down-spouts present problems which arise when units become filled with debris. Stopped-up down-spouts allow roof drainage to run along the exterior face of the building causing damage to the caulking around window and door heads and the wall in general. During periods of heavy rain, these areas absorb an excessive amount of water. This moisture usually penetrates to the interior surfaces causing damage to the materials used for interior finishes. Routine inspection of gutters and down-spouts to insure proper functioning can eliminate this problem.

Window and Door Openings. During the original construction of a building, moisture seals are considered as an important part of the construction. However, within a period of several years, these seals may become brittle and shrink from the adjacent elements. This action will permit moisture to penetrate the building. When this occurs, the old caulking should be removed and a new bead run. This work should be done whenever exterior repairs and repainting are done.

Exterior Walls. 1. Masonry. Older brick buildings, frequently need to be re-pointed and treated with a waterproofing compound. These are specialized crafts and are not considered to be within the scope of this discussion. However, failure to treat these walls renders interior decoration virtually impossible due to moisture penetration which results in plaster and paint failure. Periodic inspection of the walls should be a part of routine maintenance and minor cracks can be re-pointed at that time.

2. Wood. Customary practice is to apply paint to exposed wood surfaces in sufficient number of coats to protect the materials from the elements. Common paint failures are caulking, alligatoring, checking, flaking, cracking, scaling, and blistering. Prior to re-painting, surfaces with these defects should be thoroughly cleaned by burning, scraping, or sanding. Failure to perform this cleansing procedure, results in a poor paint job. Mildew can be retarded by the use of additives or by the use of paint commercially prepared for this purpose.

Shifting of Structural Elements. This action is usually the result of improper drainage around the perimeter of the building. Over a period of years the exterior back-fill around the foundation settles. This allows surface water to collect which in turn softens the ground adjacent to the footings. This condition causes building movement which results in wall failure. In certain instances, planting of shrubbery adjacent to the foundations further adds to this condition due to constant watering of the plants and shrubs. A remedy for this situation requires that fill dirt be added around the building line to insure that surface water will quickly drain, and that in some cases plants causing trouble be removed. Attention should also be given to splash-blocks and other drainage structures to assure adequate drainage.

Interior Walls and Ceilings. 1. Plaster. Through age, building movement, or moisture penetration, plaster walls and ceilings become cracked. The failure of plaster due to the rusting of metal lath can be corrected by the removal of the damaged sections and replacing with new lath and plaster. Small, hairline cracks in which the adjacent plaster has not pulled away from the grounds can be repaired by using a crack filler and then repainting the area.

2. Masonry. Exposed brick becomes discolored through normal use especially around door openings and in corridor areas. These surfaces may be cleaned by using one of several commercial detergents and a stiff brush. In extreme cases, sand blasting may be necessary to restore the brick to the original color. A common practice is to paint these walls using a rubber or plastic base paint. Ceramic wall finishes are easily maintained by routine washing with a non-film producing detergent.

3. Wood. Painted or varnished surfaces can be cleaned by using an appropriate detergent. However, routine re-painting on

a fixed schedule should be a part of the maintenance program. Paint or varnish that has cracked or alligatored should be removed and a new finish applied.

D. WINDOWS AND CURTAIN WALLS

In order to reduce the maintenance cost of windows and curtain walls, certain practices are important. Some of these are (1) to choose materials which are durable, long-lived, and easy to clean, renovate, and replace; (2) to use apparatus and equipment which are reliable; and (3) to consider initial cost versus upkeep. The practice of designing for initial economy has frequently led to embarrassment. Using cheap materials to reduce construction costs generally results in increased maintenance and replacement costs. This is true whether the life of the structure is deliberately set low in anticipation of rapid obsolescence, or whether the structure is a stop gap to provide temporary housing to meet crowded conditions. Economy in maintenance and repair begins with design considerations.

With the advent of new methods of construction, windows have been expanded into the whole of the exterior wall. This new consideration has made windows a more inclusive element of the building from the point of view of construction. Atmospheric conditions common to the specific area in which the school is being constructed should be considered before a final decision is reached.

Weathering and Corrosion. Materials used in windows and curtain walls require a high degree of resistance to weathering. The effects of weathering may be seen in faded colors, reduced strength, erosion of the surface, and the destruction of materials.

One of the most destructive weathering forces is atmospheric corrosion which causes deterioration of the surface of materials through oxidation. This type of weathering is much more serious in some materials than in other materials. In all materials affected by atmospheric corrosion, the force of destruction appears to be hastened by the greater air contamination found in industrial areas and in the salt air of the seacoast.

Another destructive weathering force is sunlight. However, it has not been found to affect the major windows and curtain wall components to any great degree. It does attack sealants, gaskets, and paints, and it tends to hasten the fading of colors. In certain areas, abrasion of surfaces by wind-blown sand or other materials may be a problem if the materials used have low resistance to such attack. Chemical corrosion may be a problem in certain locations subject to fumes or chemically contaminated air and marsh gas. The effects of alternate freezing and thawing may have serious consequences in walls with facings of stone, concrete, ceramic tile, or masonry. When wet, some types of insulating materials may give trouble in freezing weather.

A third destructive weathering force, corrosion caused by the action of a flow of electricity from one material to another, must be taken into consideration in any curtain wall designs. This action is called galvanic or electrolytic corrosion. Rain water or condensation containing chlorides or salts ordinarily acts as the electrolyte in galvanic corrosion affecting curtain walls. Water passing over one metal and dripping or running onto another can cause this harmful corrosion.

Common Window and Curtain Wall Materials. Windows and curtain walls may be constructed by using various materials. Some of the more common materials are aluminum, stainless steel, carbon steel, galvanized iron, porcelain enamel, wood, ceramic tile, and glass.

Care and Cleaning of Aluminum. Methods required for routine cleaning of aluminum vary with the type of soiling, frequency of cleaning, and other factors. For routine cleaning, usually the mildest method will work easily and well. First, wash with clear water and dry thoroughly; second, wash with mild soap and warm water, rinse and dry; or use a non-etching chemical cleaner.

If the aluminum has accumulated a thick coating of dirt, it may prove easier to remove the heavy dirt first with a solvent cleaner. It may be helpful to use one of the following methods:

1. Use a wax-base polish cleaner with a clean, soft rag or pad, following manufacturer's directions
2. Use a nonwax-base polish cleaner with a clean, soft rag or pad, following manufacturer's directions
3. Use an abrasive wax with a clean, soft rag or pad, following manufacturer's directions
4. Use a mild abrasive cleaner or a damp, clean cloth and rinse well and dry
5. Use a stainless steel wool pad with liquid wax or one of the above cleaners.

Caution should be exercised in using steel wool or abrasive waxes and cleaners since the appearance of the finish may easily be damaged. Rubbing with steel wool or abrasive cleaners should always be in the direction of the metal's finish. Use special care in rubbing a caustic-etched surface which shows no direction or "grain." A bristle brush is recommended for the use of all cleaners on patterned surfaces.

Care and Cleaning of Stainless Steel. (Note: Never use ordinary steel wool.) Properly polished and prepared surfaces of stainless steel will remain untarnished indefinitely, but such surfaces must be kept clean and free from accumulations of soot, dirt or particles of other metals. To keep stainless steel surfaces clean, wash with soap and water, rinse with clean hot water, and dry with a clean cloth. If a polish or abrasive is necessary, the highest quality household cleaning compounds are recommended. Do not use liquid or other metal "polishes" or "cleaners." They are unnecessary and may be injurious. Never use ordinary steel wool, as it may leave a film of iron which will discolor and may even cause rusting of the stainless steel.

Finger marks and smears on polished surfaces may be easily removed by rubbing with a clean, dry cloth and a little dry whiting. If badly smeared, gasoline or carbon tetrachloride may be used, followed by whiting. For smears not readily removed with the above methods use stainless steel wool, which is available from most specialty suppliers.

Care and Cleaning of Other Metals. In addition, there are special processes and forms available for cleaning stainless steel, aluminum, bronze, and other metals that are either in use at present or may be in the future.

Carbon Steel. Some of the first standard or stock curtain wall systems erected were made up of carbon-steel frames with integral windows and inserted panels. Ordinarily furnished with hot-rolled steel frames, cold-formed minor components and porcelain-enameled, aluminum, or other types of panels, this type of wall has had numerous applications and will probably continue to be used for walls in which low cost and high strength are major factors. Types on the market with standard components allow for a choice of projected, fixed, double-hung, and other windows, and almost any type of panel; which may be inserted into the frame in various ways. Fabrication of carbon steels is similar to that for stainless steel, except that it is generally easier.

Galvanized Metals. Although galvanized metals have been used in contemporary curtain walls for exterior facing of panels, the practice is not recommended because of the relatively poor weathering qualities and painting requirements. For interior facing galvanized metals are used extensively. The materials usually demanded for interior work are those which can be readily painted; their weathering qualities are unimportant.

Wood. Although wood has not found its way into window wall construction to a significant degree, wood windows are present in some buildings. Various woods have been used for window construction and are not to be treated in this discussion since this is properly discussed as a material of construction. Wood is subject to the elements and as a consequence must be protected by paint. Regular inspection will indicate how often repainting is required.

Cleaning and Maintenance of Curtain Walls. The method of cleaning curtain walls varies according to the type of materials used. Specific methods of cleaning are listed with the general discussions of the materials themselves. In general, if excess sealants or other preparations are cleaned up by the contractor immediately after erection, the final cleaning will consist simply of washing the wall surfaces with clear water and cleaning the glazing in the usual manner. If they are severely stained, any of the materials used in curtain wall work may be washed with mild soap and clear water with soft brushes.

All cleaning with soap should be followed immediately with clear water rinses to remove all traces of the soap. When cleaning with soap and water is not sufficient, the methods recommended for specific materials can be applied, but the supplier of the materials should always be consulted.

Routine maintenance of the curtain wall may consist of periodically washing down the entire wall (along with the windows) with soap and water. For some walls (generally those on buildings located in rural areas) there is very little dirt accumulation, and a minimum of housekeeping maintenance will be required. In buildings located in industrial or urban areas or on the seacoast, frequent cleaning may be necessary to maintain the wall's original appearance.

Major maintenance or repair of curtain walls is a subject that has had little attention. This is not to say that the problem is unrecognized, but the fact remains that relatively few walls have been designed for easy removal and repair or replacement of defective or damaged parts. Few currently used components can be effectively rehabilitated while still in the wall. Nor can they be removed from the wall except with the greatest difficulty. Units erected from the interior ordinarily have fasteners in positions impossible to reach without tearing up the floor or the backup.

Units erected from the outside could be more easily removed were it not for scaffolding or other devices. In this role, the window-cleaning platform might prove to be of great value, serving an additional function that would help to justify its cost.

A question related to maintenance is that of re-use of panels or components. This consideration does not usually affect choice of a wall type; but for installations erected for temporary purposes, it might be a very important one. Many types of curtain walls might satisfy this requirement. Most standard industrial walls as well as many stock walls or other types should have good possibilities for salvage.

Of course, custom walls would have little or no re-use value unless a second building were specifically designed for them. Even then, much of the wall would probably be damaged beyond repair during removal from the original structure.

Types of Panels for Window Walls. In addition to the structural material of windows, a brief discussion of the types of panels for window walls should receive some attention. There are many possible combinations of such materials to numerous to outline in detail. Of these materials, porcelain enameled steel and ceramic tile panels are the most commonly found.

1. Porcelain Enamel. Porcelain enamel, which might more properly be called vitereous enamel in order to distinguish it from paints, is a completely inorganic substance. Closely akin to glass, its primary function in curtain wall design is the coating of other materials to impart qualities these do not normally possess. Among such properties are highly permanent color in a wide range, weather resistance, ease of cleaning, and long live. The use of porcelain-enameled products in architecture has grown rapidly since World War II, and one of the more spectacular uses has been in curtain walls.

After erection, porcelain enamel curtain wall parts should be thoroughly cleaned with mild soap and water. Hard-to-remove dirt may be scoured lightly with household cleanser. Protective coverings are not usually used for porcelain components, but consideration should be given to the provision of removable strips of paper or other means of protecting the surface from the rigors of erection.

2. Ceramic Tile Panels. At the present time, ceramic-tile-faced panels are available in two forms: (1) adhered to the face of aluminum or galvanized metal panels, and (2) cast on the face of concrete panels in a manner similar to that of ceramic-veneer-faced

concrete panels.

Some properties of ceramic tile, such as wide-ranging color and texture, and resistance to weathering and abrasion are well known. Only a few properties of the material, apart from those of the panels to which it is applied, are of importance. The most important of these is the ability of particular types to withstand alternate freeze-thaw cycles. In this respect, ceramic tile is similar to other ceramic materials and to stone. Some ceramic tiles, because of their relative porosity and other factors, are not suitable for use on exteriors subject to freezing. Care should be taken to insure that materials chosen are certified for exterior use in the geographic region of the building.

Another factor affecting the weatherability of ceramic-tiled-face panels is the type of adhesive used to mount the tile to metal panels. Only organic types that have been thoroughly tested are recommended. A third important consideration is the choice of grout used for pointing the joints. Test results showed conclusively that the type of grout used is of utmost importance. Some types cracked and failed, whereas others stood up very well. The tile itself and its adhesion to the panel were scarely affected.

Protection of ceramic-tile-faced panels parallels that for other curtain-wall components and for tile generally. Special precautions should be taken to insure that the tile facing is not endangered by loads on the corners or heavy impact loads on the face. Cleaning of the completed panels ordinarily consists of wiping the joints clean after grouting, and washing the entire face with clear water and (if necessary) mild soap. Acids or abrasives should not be used for the cleaning of ceramic tile.

Glass. The most important part and most vulnerable portion of the window is glass. There is a growing tendency on the part of designers to use large panes of glass both for fixed and operable sashes. This is costly. It may necessitate the use of expensive plate glass instead of the cheaper double strength glass. A large operating sash is more difficult to open and close and requires more maintenance. Special glass, such as tempered glass, heat-absorptive glass, glare shielding glass, double glass, or glass block, is seldom justified economically. However, it may be used in terms of the plan and program of a particular school. The degree of contribution to control of the thermal and visual environment must be the determining factor. Difficulty of replacement as well as initial cost needs to be taken into account in any use of large panes or special glass.

When the necessity to change glass occurs, it is important to prepare the window frame for the new glass by removing all broken fragments of glass. Be sure to wear gloves. Use a putty knife or screw driver to remove old putty, being careful not to splinter the wood. Pry out the small triangular-shaped pieces of metal, glazier's points. Brush away putty fragments and all dirt or dust. Measure the opening for the proper glass size. (The glass should be one-eighth inch smaller than the opening.) Apply a thin layer of fresh putty on all four sides of the sash into which the glass will be set. The bottom edge of the new glass should rest on a glazier's point, so that the glass will not be flush with the wood. Next, press glass into place, firmly but gently. Be sure that pressure is equal at all edges to avoid breakage. Insert the glazier's points in order to hold the glass firmly in place. One or more of these points should be on each side of the glass, depending on the size. Excess putty can now be removed from the inside of the panel. The sash is now ready for the putty. (Apply enough putty on all four sides.) First work the putty to the consistency of bread dough, which is very smooth. Roll it into workable one-half inch strips. Hold the putty in one hand and the knife in the other. Feed the putty continuously as the stroke is made. Do not work in short and repeated strokes. This will tend to give you a patchy, irregular effect. For best results hold the putty knife at an angle to make a smooth, beveled seal. Let the putty dry for several days, then paint it to match the windows. If not painted, the putty will shrink from the glass and let water seep through, causing deterioration of the sash.

Maintenance Caused by Abnormal Use and Vandalism. In the discussion of maintenance up to now the materials themselves have been discussed. However, the most difficult of the maintenance problem is that of abnormal use and vandalism. The only remedies here are on the choice of the materials in construction that lend themselves to the most abuse with little or no effect. Even this does not solve all of the problems. Only discipline will help, and continued replacement of parts will act as a deterrent in that the damage incurred does not become a suggestion for all to try.

Maintenance Resulting from Mechanical Failure. Mechanical failure occurs in the moving parts of all windows. In the double hung window the various types of balances are the most important items.

Sash balances of the spiral type, the spring type, and the weight type are the most common. All of these types eventually require replacements. It is important, however, in replacing sprial and spring balances that the weight of the sash be known when replacements are ordered. In the case of worn or damaged tape it is necessary to change the whole balance. This can sometimes be avoided if the balances are placed in the jamb at the meeting rails instead of at the head.

Although the weight balance has gone out of fashion, many schools of earlier vintage still have them in use. If cords are presently used they should be changed to chains, since this will lessen future maintenance. If this is done it is necessary that the pulleys be replaced with cast iron roller-bearing type pulleys.

The awning type window has mechanical failures in the cranking gears that wear and require replacement. Another failure occurs from the window being cracked during installation. All of these types of windows should be checked carefully before acceptance of the buildings. In time these types of windows can be sprained by carelessness of operation, which can require the replacement of all the operable parts.

Maintenance of Window Shades, Blinds, and Curtains. Other periodic maintenance tasks are concerned with the repair of window shades and blinds, and dismounting, dry cleaning, and remounting draperies and curtains. Most cleaning and dusting operations are functions of the custodial staff, but repairs may be made by the maintenance department, depending on local policy. Where special equipment is required to make such repairs, however, it seems appropriate that this work be done by regular maintenance men. For example, certain types of window shades are manufactured so that the rollers do not have to be replaced as often as the cloth. In some instances, it is possible to reverse the cloth on the rollers to obtain further service from the same shades; when this cloth becomes worn, soiled, or is torn, it can be replaced by new cloth. This procedure, while not difficult should be done with precision if satisfactory results are expected.

Venetian blinds may also require expert workmanship when being repaired. Individual slats may be bent, kinked, or damaged; pull cords, cord locks, tapes, and cross ladders wear out. In order to replace these parts, or to make repairs, it is often necessary to disassemble the blind. Such work can be done more effectively in the workshop.

Another illustration of similar maintenance is demounting, dry cleaning, and remounting auditorium and window draperies and curtains. This should be done every four or five years to prevent rotting. The maintenance crew should be able to handle this job more efficiently than the custodial crew.

Weatherproofing Windows, Doors, and Walls. A common source of damage to buildings is moisture penetration. Points of penetration are outside windows, doors, and walls. Regardless of the type of material used, or how well buildings have been constructed, the ravages of climate tend to break down exposed surfaces. This weathering process not only contributes to deterioration but also shortens building life.

Eternal vigilance is required to discover points where putty and calking compounds have fallen away, where masonry joints have opened, and where other exterior surfaces have cracked. Prompt action in resealing, recalking, replacing putty, repointing masonry joints, and repairing cracks will keep joints tight and moisture-proof, thus effecting savings in renovating costs and prolonging building life. There is no way to predict with certainty the exact interval at which these weatherproofing jobs may have to be performed, but experience indicates that the span is between five and ten years, depending upon the quality of materials, standards of workmanship, and local climate.

E. ROOFS

The roof is one of the most important and least checked parts of a building. It is important because it protects the building from the elements. It is overlooked because of its relative inaccessibility.

Preventive Maintenance. The maintenance department should make a careful visual check of the roof at least once each year. This inspection will often reveal weaknesses that have not yet developed into leaks.

Great care should be exercised in moving about and working on the roof. No foreign materials should be left or stored on the roof because the waterproof membrane part of the roof is easily damaged. If it is necessary to have heavy traffic over the roof or temporarily store materials on the roof, catwalks and platforms should be constructed to protect the surface.

Roof Bonds. Most school roofs are bonded. This means that the manufacturer of the roofing materials gives the owner a written bond guaranteeing the roof against leaks for the period of the bond. The bond usually remains in effect for twenty years following application of the roof. In bonding a roof the manufacturer requires that the roof be applied by one of their licensed applicators in accordance with the manufacturer's specifications for the type of roof involved. The bond also limits the liability of the manufacturer to damages caused from inferior materials and workmanship. It is particularly important to remember that if the owner damages or cuts into the roof for any reason, the bond is automatically canceled.

Roof Slopes. Most roofs have some pitch for drainage. Even the usual flat roof will have a slight pitch built in. If a roof is perfectly level, it is called a dead-level roof and must be specially treated. Roofs that have an obvious pitch for drainage are called sloped roofs. Since the slope of a roof can be theoretically anything between the horizontal and the vertical planes, it is important to state the slope in conjunction with sloped roofs. The slope is customarily given as units of rise in twelve units of run. For example, if a roof has a slope of five in twelve, it will rise a vertical distance of five inches in a horizontal distance of twelve inches.

Another roof sometimes used is the curved surface. This roof can take a number of shapes, such as simple curves like vaults or waves and compound curves like domes or hyperbolic paraboloids.

Maintenance Procedures. The first thing that should be done when a leak occurs is to check for a roofing bond. If a bond is in force, the applicator of the bonding company should be contacted to correct the trouble. The owner should not make any repairs which would cancel the bond. If there is no bond in force, the owner should proceed with repairing the roof himself.

Leaks in a built-up roof generally result from breaks in the surface caused from blistering, drying and shrinking, or injury from a foreign object. A small break can be repaired by applying a roofing cement. Large breaks should be patched by removing a section of the roof surface and replacing in the same manner that the original roof was installed. Be sure to use the same kind of materials as the original roof. Asphalt and pitch do not mix very well. In patching the roof, be sure that each layer of the patch overlaps the previous layer by at least two inches.

Leaks in an asbestos, slate, tile, or cement shingle roof are generally caused by a cracked shingle. In this case the shingle must be removed and replaced with a new one.

Leaks in an asphalt shingle roof can be caused by nail holes, nails backing out of the sheathing and shingles torn off by wind. Nail holes should be patched with cement. Loose nails should be removed and a new nail driven into a new hole. Torn shingles should be replaced with new shingles.

Leaks in a wood shingle roof may be caused by rotted or split shingles. Damaged shingles should be removed and replaced with new shingles.

Leaks in an aluminum shingle roof will most likely come from damage caused by injury. Aluminum expands and contracts radically with temperature changes. This can cause shingles to become loose. Loose shingles should be refastened.

Leaks in a porcelain enameled steel shingle roof will most likely come from rust holes in the shingles. This action may be difficult to detect. Any rusted shingles should be replaced.

Leaks in a corrugated or "V" crimp metal roof can be caused from small holes in the metal, loose fasteners or loose joints. Generally, this type of roof is laid over purlins. Small holes can often be detected by looking from inside a darkened building. Light from outside will show through. Small holes can be plugged by inserting a sheet-metal screw with a neoprene washer. Loose fasteners should be replaced. Loose joints should be sealed with a roofing compound and pulled together with gasket head sheetmetal screws. Excessive corrosion calls for replacement of the affected panels.

There is no easy way to detect leaks in a standing or flat seam roof. Leaks are generally from very small holes caused by corrosion or impact. If possible, holes should be soldered. Holes can be repaired with a roofing cement. Flat roofs can be painted with special compounds.

Leaks in canvas decks are usually caused by cracking. Canvas decks should be painted with special deck paint every year. If the roof has been painted and is still leaking the canvas has in all probability rotted. In this case remove the entire deck covering and replace with new canvas and paint.

Leaks in a cement finish deck are nearly impossible to detect and just as difficult to repair. Coating the entire deck surface with a waterproofing compound may stop the leak. It will usually be necessary to remove the entire roof surface and replace with new materials including the built-up portion. Roofing companies will not bond this type of roof.

Leaks generally will not occur in a plastic coated roof surface. When leaks do occur, the entire surface should be given a coat of the sealing material.

Flashing and Vents. The weakest points in a roof surface are at the breaks. These occur where ventilators or walls project through the roof surface and where sloped roofs have valleys and ridges.

Such breaks are protected with flashing. Flashing is usually made of metal. Copper, lead, and galvanized iron are the most common flashing materials. Flashing at wall junctions is sometimes done with built-up roofing materials.

Leaks in the flashing usually come from holes caused by corrosion or impact. If possible holes should be soldered. Patching with a plastic roofing compound is acceptable. Check vent pipes to be sure lead flashing has been turned down into top of pipes.

Gutters, Downspouts, Facias, and Drains. It is important to conduct water away from the roof as soon as it falls. Roof surfaces are not designed to hold standing water. Be sure that gutters, downspouts, and drains are kept cleared. A flood on the roof caused by a stopped drain can work through flashings and leak into the building.

If water gets behind a wood facia, it will cause rotting. If this happens, replace the rotted wood and install flashing to prevent recurrence.

Parapet Walls. Many old buildings and some new ones were built with walls extending above the level of the roof. Water is carried off either by drains through the building or by scuppers through the parapet wall. Roofing is flashed into the wall as described above. The parapet walls are topped with a coping of metal, tile, cement, and stone.

Aside from the flashing leaks which are quite common for this type of construction, the wall itself can leak. When this happens the inside surface of the wall should be waterproofed.

Special Treatment. At least one major roofing company has developed and put on the market a special coating for completely covering old roofs.

It is suggested that this or a similar system be used if the roof is in bad shape.

CHAPTER III

MAINTENANCE OF INTERIOR FACILITIES

Proper care of interior facilities of a school plant is an important phase of the maintenance program. Numerous items are considered as interior facilities. Some of the more common are floors, plumbing systems, electrical systems, heat and air conditioning, hardware, and furniture. A detailed presentation relative to the maintenance of major interior facilities is presented in this phase of the report.

A. FLOORS

In considering floor maintenance in school plants it must be realized that many types of floors are in use in public school facilities throughout Louisiana. In addition, the difference between floor maintenance and floor cleaning should be clarified. While it is difficult to separate these two phases, there are certain features which differentiate both phases. Cleaning should be performed by the custodial staff; whereas, maintenance should be performed by maintenance personnel. Proper floor maintenance serves to decrease custodial care and to extend the life of the floor.

Concrete Floors. Concrete floors are found in corridors, classrooms, toilets, locker rooms, and stairs in many of the older school buildings. However, floors of this type are also being used in some new buildings where strict economy is practiced. Concrete also serves as a sub-base for such floors as linoleum, mastic, terrazzo, and wood.

Modern architects make concrete floors more durable and attractive by using color pigments and metallic hardeners.

"Dusting" or pitting of a concrete floor comes from improper construction. Either the mixture was faulty or the curing and finishing were not properly done.

If the floor dusts excessively, it should be scrubbed weekly for several weeks with a neutral soap. If the dusting continues, the floor should be scrubbed with steel wool (under a scrubbing machine), then cleaned with a neutral soap, rinsed, allowed to dry, and then treated with a concrete hardener.

Seals will wear in traffic lanes, however, resealing can be done easily without showing a lap. It is not necessary to reseal along walls or other areas of limited wear.

Concrete floors can be waxed rather than sealed with practically the same effects. Probably the best results can be obtained by sealing the floor and covering the area with a thin coat of wax. Too much wax will make the floor slippery.

If floors are badly worn or pitted, a new surface should be constructed by a reliable contractor who understands concrete construction.

Painting Concrete Floors. It is practically impossible to get good results from painting basement floors where moisture penetrates the slab from below. This action causes the paint to be pushed off the surface. Too, moisture-laden air condenses on the floor before the paint dries. For the best results the atmosphere must be dry when painting is done.

Care must be taken in the selection of paint to be used on concrete. It must be a paint specially prepared for concrete. There are some paints with abrasion-resistant pigments and some with a phenol-resin bases that have given satisfaction. Perhaps the best type of paint is one with a rubber base which gives a durable surface and is resistant to alkali and water. New concrete should not be painted for at least six months after installation.

In applying paint to concrete, be sure of these conditions:

a. The surface is thoroughly clean. Special solvents can be used to remove oil and grease. Old paint and wax should be removed.

b. There are no rough spots on the surface.

c. The extremely smooth surface is roughened slightly. Etching by scrubbing with a 10 per cent solution of muriatic acid may be necessary. To do this, first dampen the floor, then wet with the acid solution and scrub with a fiber brush. Mop the floor with clear water and allow to dry.

Use three coats of paint for best results. Follow manufacturer's directions. Allow four or five days to dry. A thin coat of wax is not necessary but will help preserve the life of the floor. New floors also should be etched with muriatic acid.

Terrazzo Floors. Terrazzo is simply cement mixed with marble or granite chips and therefore requires about the same type of maintenance as concrete. This type of floor is hard, smooth, durable, and easily maintained. It cracks easily and can be ruined if not treated properly.

No acids or alkaline cleaners should ever be used on terrazzo. Acids cause the calcium in cement and marble chips to break down. Alkaline cleaners cause terrazzo to pit and dust. Abrasive cleaners should not be used except where a floor is very badly stained from traffic. Steel wool should not be used in scrubbing terrazzo. If a mild abrasive is necessary it should be sprinkled on a small area at a time and scrubbed with a floor machine, followed by a squeegeeing off of the dirty water.

Varnish, lacquers, and regular wood floor seals should not be used on terrazzo. Varnish has a tendency to crack or peel and discolor the floor. Oily dust mops and sweeping compounds should not be used as oil discolors and deteriorates terrazzo.

For best results terrazzo floors should be treated with hardeners or seals especially made for this type of floor. The best type of seal is made from plastics which may be removed, if necessary, in their own solvents. The seal should be of the penetrating type, not surface seal.

A thin coat of water wax may be used instead of a seal. It has the advantages of being easy to apply and remove, of drying quickly, and of having a better gloss, but it has the disadvantage of making the floor slippery.

Terrazzo floors should be cleaned with a damp mop and neutral soap. If a dry mop is used it should be dampened with a wax-type spray.

New terrazzo floors should be scrubbed two or three times a week and mopped on alternate days. Rinse after each scrubbing. The floor will become more beautiful and require less upkeep after two or three months of this treatment.

Marble and Mosaic Floors. Although marble is seldom used for floors in school buildings, there are some buildings where sections of walls or floors are marble.

Strong caustic alkalies or acids should not be used in cleaning marble but mild alkaline cleaners or abrasive cleaners may be used without damage. To clean, first wet the floor with hot water, sprinkle the cleaner over the wet area and scrub either by hand or with a scrubbing machine. Do only a small area at a time, once or twice a year.

Daily cleaning of marble should be done with clean water, a clean mop, and a soapless or synthetic cleaner.

Oil sweeping compounds, greases, oily mops, steel wool, and steel wire brushes should not be used on marble. No metal that rusts should remain on a marble floor. A marble sealer may be used on a marble floor but water wax is preferable. If a marble floor is kept clean it is usually not necessary to seal or wax it.

Tile Floors, Ceramic, Glazed, Unglazed, and Quarry. Acids and alkalies on tile floors cause deterioration of the grouting. Heavy soaps make tile floors slick. Neutral soaps or mild detergents should be used and the floors damp-mopped. Follow with clear water rinsing. Do not use abrasives or oils.

Magnesite Floors. These floors are sometimes trowled over other floors. They may also be obtained in block form. They should be treated the same as concrete floors.

Flexotile Floors. Flexotile is an oxychloride cement floor installed over either wood or concrete foundation floors. Mop with a neutral-base soap. Seal once a year with a clear penetrating seal after the floor has been thoroughly cleaned.

Acmetyle Floors. This is terrazzo type floor or an oxychloride type that is used for corridors, classrooms, and toilets, but is not recommended for use under shower heads as excessive water is too severe on the material. Damp-mop with warm water and a small amount of neutral soap or mild laundry soap and wipe dry. This floor can be kept in good condition by an occasional application of neutral oil. A mixture of raw linseed oil and kerosene or turpentine (half and half) is satisfactory. The floor should be clean and the mixture rubbed into the surface. All surplus oil should be removed. Never use alkalies or strong washing powder. Any spirit wax can be used for a polish. Water emulsion waxes are not recommended.

Rubber and Vinyl Tile Floors. This type of floor should not be installed on damp concrete. Do not use alkaline soaps, oils, abrasives, naphtha or any mineral oils on these floors. Clean with a dust mop. Damp mop occasionally with clear water or a mild solution of tri-sodium phosphate. Air and sunlight cause rubber tile to crack or check. This can be prevented somewhat if a light emulsion is used on the surface occasionally. Apply two coats and then buff with a soft bristle brush or lamb's wool pad. Buff lightly and frequently. Do not use turpentine or petroleum base waxes or sweeping compounds. Do not use shellac, varnish, or lacquer on a rubber tile floor. To prevent denting, all furniture legs should rest on glides or wide rubber casters.

Linoleum Floors. Linoleum should be laid over a smooth masonry surface. Too much washing harms linoleum. Keep the floor dry. Use a damp mop with a neutral soap for cleaning. Rinse with clear water and allow to dry.

Wax the same as rubber tile, using only self-polishing wax. The solvents in paste wax are harmful to linoleum. Remove rubber heel marks with a cloth moistened in carbon tetrachloride. Do not use abrasives or strong soaps, varnishes or lacquers, oily sweeping compounds or heavy oil mops on linoleum. The floor should be buffed frequently. When buffing fails to produce a shine, rewaxing is necessary. Too much wax is better than insufficient application.

Asphalt Tile and Mastic Floors. This type of floor can be laid on damp ground or in basements. Extreme heat or dryness affects this type floor. Oils, spirit solvent waxes, strong detergents and cleaners, kerosene, gasoline, and turpentine should not be used. Sand and dirt mar the surface. Damp mop occasionally with a neutral soap in warm water. Rinse with clear water and dry with a clean mop. Remove stains by rubbing lightly with steel wool and a concentrated solution of neutral soap and warm water. Apply several light coats of water emulsion wax buffing each coat after it is dry. Do not use shellac, varnish, paste wax, or lacquer on this type of floor. For sweeping use a soft hair push broom or dust mop but no sweeping compound. Ashpalt tile floors can be highly effective if furniture legs are equipped with wide rubber wheel casters, flat glides, or composition furniture cups.

Cork Floors. Cork floors are sensitive to stains and most cleaning agents. Cleaning may be accomplished by lightly sanding with steel wool and applying a light water emulsion wax. Use a disk sander instead of a drum sander. Sweep with a soft bristle brush and keep the floor dry.

Carpets and Rugs on Floors. There are many varieties of rugs and carpets on the market. Perhaps the best method of cleaning is the vacuum cleaner or a hand sweeping compound. Do not use a corn broom or a regular sweeping brush.

Wood Floors. Wood floors are still in wide use in numerous areas in construction of school buildings. There are several types of wooden floors available. Many of these utilize woods from forests in Louisiana. Some of the more common are pine and oak. Various other types may be secured for use in the construction of wooden floors. Hard maple is in all probabilities the most popular.

A good floor finish should have the following requirements:

1. The finish must penetrate well below the top surface of the wood. The penetrating finish must permeate the wood and become an integral part of it, so that after application it will wear away only as the wood itself wears away.
2. The finish must seal the pores, so as to keep out dirt and resist soil stains.
3. The finish, with its penetrating qualities, must not darken the wood, but must give the floor an attractive

satin-like sheen, allowing the varying natural color of the wood to show.

4. The finish must reflect light, so as to improve illumination.
5. The finish must be non-slippery.
6. The finish must not mar, scratch, and flake off.
7. The finish must be of such quality that, if it becomes necessary to touch up worn spots in heavy traffic lanes, it can be done without complete refinishing and still present a uniform appearance.
8. The finish (sealer) should be resistant to water.
9. The finish, after application, must not present a maintenance problem. Maintenance must be economical without need, under normal conditions, for constant resanding and complete refinishing.

A bakelite type of finish may be used on gym floors. This finish penetrates the wood, does not darken the wood, does not show rubber burns, and is not slippery.

Sanding. If floors are rough and in bad condition they should be sanded at a 45 degree angle, two ways, then in the direction of the grain. Use No. 2 sandpaper for the first traverse, No. $\frac{1}{2}$ for the second, and No. 0 for the third. Four or five sandings may be used to give an exceptionally smooth surface using No. 000 sandpaper on the last cut. Use a hand sander along the baseboard.

After the floor is sanded, a filler or first coat of finish should be applied and allowed to dry. Floor seal can be mopped on with a clean string mop, an applicator of lamb's wool, a squeegee, or a wide brush. Wipe off all excess seal. Buff the floor with steel wool, using an electric buffer. Two coats of seal are sometimes needed on new floors or newly-resanded floors, but the seal should not be "stacked" on the floor.

After the floor is sealed, it should be waxed with either paste or liquid wax, applied according to the manufacturer's directions. One coat is usually sufficient.

If floors are scrubbed instead of sanded they should be allowed to dry thoroughly and then treated as new floors. All wood floors, if correctly finished, can be cleaned with a dry mop and mineral spirits or a recommended floor cleaner. Shellac, lacquer, varnish, and stain are seldom used on school building floors.

Pine, fir, and spruce floors are found in many school buildings. Pecan wood blocks are used in some shops and gymnasiums. These soft wood floors take the same treatment as hardwood, but care should be taken as to the type of seal and filler used on them. Wood block floors should be given the same treatment as other wood floors. Soft woods are susceptible to stains, splintering, and ridging. They are also more porous and take more coats of sealer than do hardwood floors.

Do not use soft wax on floors as it holds sand and grit and therefore causes floor wear. Do not use oil on floors.

B. PLUMBING SYSTEM

The information concerning maintenance of plumbing systems has been prepared for the purpose of assisting personnel responsible for the proper operation of the school plumbing system. Only emergency repairs and maintenance are covered in as much as design and construction are of such a specialized nature so as to require trained and experienced personnel.

Routine Maintenance. A good plumbing system depends on good design and proper installation; however, even the best system cannot be expected to continue functioning without maintenance. The familiar saying, "An ounce of prevention is worth a pound of cure" applies very well to plumbing. The time and cost necessary to organize and execute a good maintenance program are far less than would be needed to repair faults due to the lack of proper maintenance.

Emergency Repairs. Permanent type minor repairs, such as replacing individual fittings, stopping leaks, and unstopping sewers, are jobs frequently required of maintenance personnel. Temporary major repairs may occasionally be demanded, but permanent major repairs should be made later by a plumbing craftsman.

Water Supply System. The piping system may consist of cast iron, asbestos-cement, galvanized steel, copper, or other materials. Cast iron water main pipe may be lined or coated. Pipe in sizes of two (2) inches and smaller may have threaded joints, while larger pipe may have calked lead over asbestos rope, treated rope, tubular rubber rings or the newer slip-on type of rubber ring or other materials approved for water lines. Asbestos-cement is considerably different from the other pipes listed in that it is non-metallic (white to very pale grey in color). Joints are of the slip-on type, using rubber rings. Galvanized steel is the material commonly called "galvanized" pipe. Joints are usually of the threaded type. Copper tubing can be either of the rigid or flexible types. Joints are usually soldered with appropriate fittings; however, flared type joints can be used on flexible tube types.

All water mains should be kept, as much as possible, away from any source of contamination, such as sewer lines, and these mains, should be located and/or insulated so as to prevent freezing. All underground pipe should be supported on a firm bed for the entire length. When pipe is dug for repairs, care should be taken to replace the firm bed below the pipe and properly backfill over the pipe with tamped thin layers of dirt.

Leaking joints should be repaired whenever located. If tightening does not stop leakage at threaded joints, a Dresser type coupling or a clamped on type may be used. Pipe joint compound is a lubricant and not a sealer. It should be applied to the male threads so that excess is squeezed out of the joint and does not form hard masses on the inside to clog valves. Recalking or hammering the solder back into calked or solder joints will often stop the leak. If this does not work, a clamp type coupling may be used. A copper water line may be resoldered provided thorough drainage has occurred. This action will permit copper pipe to be heated beyond the boiling point of water. A small hole in cast iron pipe, a crack around the barrel of the pipe, or a short crack along the length of the pipe can be repaired with a clamp-on type coupling. Craftsmen should replace the joint of pipe whenever practicable, except that a specially trained crew might replace pipe with slip-on joints. For galvanized steel pipe, clamp-on repair devices can be purchased or made up. A gasket material can be clamped over the leak if it is a hole or split along the pipe. Screw type couplings that expand a rubber gasket to seal against the pipe walls can also be used.

A leak or break in copper tube may be repaired by most of the methods previously listed; however, replacement is not difficult. If draining is possible, replacement with solder type fittings may be accomplished. On flexible tubing, flared joints could be used in replacements.

As far as possible all water lines should be accessible, and access doors on panels should allow inspection and maintenance to lines and appurtenances. The locations of all lines should be known as should line valves, so that any break can be quickly isolated.

Air chambers or patented water shock wave arresters, installed in key locations, are required to eliminate noise and possible pipe damage due to water hammer. When water flowing through a pipe is suddenly stopped by the rapid closing of a valve or faucet, the force of the flowing water changes to a surge pressure which may result in bursting the pipe. Air chambers or patented shock absorbers cushion the surge. Air chambers are vertical pipe extensions past the level of the fixture connection. This is normally filled with air; however, in time, especially on hot water lines, the air may dissolve into the water and the air chamber would become water-logged, much as a pressure tank might. At least annually, the water system should be drained until air is drawn back into each faucet; the water service should then be turned on, trapping any air above the fixture connection level. When patented devices are used, this procedure is not required since the air cushion is separated from the water and would not be lost or the device may absorb shock by mechanical means.

A leak in a union which cannot be stopped by merely tightening can usually be stopped by breaking the joint and placing a gasket between the ground faces of the union.

Leaking or broken fittings should be replaced. The replacement should include a union because of the simplicity of making joints. Unions are often not used in copper piping. If replacement of a fitting is not available, a different sized and/or different type may be used. When different sized fittings are used, a larger bushed down size is best. Replacement with a proper sized fitting as soon as practicable is imperative. Examples of replacement with different type fittings would be the use of a tee with plugged side outlet for a coupling or a tee with plugged run for an elbow.

Gate valves may be installed on pipes in any position and with either face against the pressure. They are usually installed whenever volume regulation is not required and full waterway is desired. Dirt and grit should be cleaned periodically from seat wedges. To stop leaks that develop in stuffing boxes or gate valves shortly after installation, the packing nut should be pulled down. Bolts on gland-flange type stuffing boxes should be tightened evenly in order to prevent twisting the glands and binding the stem.

If leaks develop after valves have been used for some time, the stuffing boxes may need repacking. When this occurs it is advisable to remove stuffing box and gland, take out the old packing, and clean the valve stem and stuffing box thoroughly before inserting new packing. If valves have split-ring packing, replace several rings at one time and pack into position, using the packing gland as a tamping tool. Add enough rings to fill the box, staggering ring splits. When parts are reassembled, take a few turns of the handwheel and add a few drops of oil to help work packing to the stem.

Globe and angle valves are usually installed on water lines to shut against pressure. They operate more efficiently in hot water, steam, and similar lines when installed with pressure above the disk. If dirt, grease, or foreign substances are lodged on seat or disk the stem and disk should be removed and cleaned thoroughly. Whenever necessary, renew the disk and seat in the same way as for faucets. Leaks are stopped in the same manner as in gate-valve leaks.

Check valves are classified as horizontal swing, ball-seating, and swing-vertical valves. Valves of this type are used primarily to check the flow of water in one direction, but should never be used to prevent backflow of polluted water into a potable water system because check valves do not hold tight against back-siphonage. Check valves must be examined occasionally for proper operation. Metallic disks may require regrinding, and others may require replacement of leather-faced disks.

Badly worn washers make compression type faucets noisy, hard to operate, and wasteful of water. Moderate force on the handle of a faucet in good repair should stop all flow and drip. To replace the seat washer, shut off the water to the faucet; unscrew the cap nut with a wrench; unscrew the stem from the body of the faucet with the faucet handle; remove the washer screw from the bottom of the stem with a screwdriver; replace the old washer with a new one and replace the washer screw, the stem in the faucet and the cap nut. A supply of varying sized washers should be available at all times. A top washer, snugly fitting the stem, is necessary to prevent leakage around the cap nut when a valve is opened. This washer is one-eighth inch thick and rests on top of the body of the faucet, making a water-tight joint when the cap nut is screwed down. It is unnecessary to shut off the water to replace the top washer for a compression faucet, provided the faucet is closed. With the right hand keep the faucet closed and with the left hand unscrew the cap nut; unscrew the handle screw; remove handle and cap nut; put on new washer; and reassemble the parts. A good quality hand-composition washer should be used.

Ground key faucets have a tapered cylindrical plunger or plug which fits snugly into a sleeve bored vertically through the body of the faucet. The plunger is rotated by an attached handle. When the handle is parallel to the faucet, the plunger slot coincides with a similarly shaped horizontal opening in faucet body. A short turn of handle to right or left throws the opening out of line and cuts the flow of water. When the plunger or its sleeve becomes grooved or worn by sand particles, water leaks through. Leaks are eliminated by polishing adjoining surfaces -- remove the plunger and apply valve grinding compound; replace the plunger and rotate it back and forth to grind the surface until the joint is leakproof. If parts are badly worn and leaks cannot be stopped by polishing, replace the faucet with a new one.

The automatic flush tank is occasionally used to flush urinals. It is composed of a high tank with a siphon or upside down "U" shaped tube which operates to discharge water in the tank to flush the urinal when the tank fills to a preset level. The frequency of flushing is determined by how fast the water enters the tank. By opening the throttling valve on the water line the tank will flush more often; by closing the valve the flushing will be less often. A stop-valve would be provided on the high pressure or water main side of the control valve. This should be used to start or stop the flush tank operation and the control valve once set should not be used as a stop. The stop-valve location indicated would allow isolation of the control valve for maintenance. Any leak in the siphon must be fixed since the air lost from the siphon will cause a malfunction. A tank which constantly discharges a trickle of water contains a faulty siphon. If it cannot be made to work, replacement of the siphon is indicated.

The flush tank is usually the type found in the home. In order to understand the maintenance and repairs of such a unit, knowledge of the of the operation of the mechanism is necessary.

When the handle is moved enough, the lever raises the upper lift wire which finally catches the lower lift wire and so raises the rubber ball off the seat. The water from the tank discharges into the fixture bowl. As the water level drops, the rubber ball floats down until it returns to its seat. When the water level is lowered, on the top of the seat, the ball will not rise with the water level because the water pressure holds it down more than the air within it wants to make it rise. When the water level drops upon flushing, the float falls with the water and the rod causes the rod lever to pivot as the thumbscrew and lifts the plunger thereby lifting the seat washer from the seat and allowing water to flow into the tank through the hush tube. A small amount of the water passes through the refill tube into the tank overflow and then into the bowl to insure that the water closet or toilet bowl is provided with enough water to seal it and prevent sewer gas coming into the room through the trap.

The float rod is bent to determine at what tank water level the plunger valve seats and thus controls the amount of water used to flush the tank. The least amount of water which will thoroughly flush the tank bowl should be used. Centering the guide over the flush tube seat and keeping the lift wires straight are necessary to allow the ball to reseat and thus let the tank fill and be ready for another flush. If the ball appears to fall properly but does not seat tight, replacement may be required. If water constantly discharges through the overflow, either the float rod should be bent to lower the water level or the float is waterlogged and should be replaced, or the plunger valve is leaking. If the valve leaks, a new seat washer should be installed -- remove the thumbscrew and take out the rod lever; remove the plunger;

replace the washer on the end of the plunger; check the valve seat and regrind if cut or scored; replace the assembly.

Flushometer valves are the flush valves found on toilets that do not have tanks. There are a few types of these valves which operate on a diaphragm or piston with water pressure on both sides. When the handle is operated, the water pressure is released from one side of the piston or diaphragm thereby opening the water line and discharging water into the fixture bowl. While water is flushing the fixture, a small amount passes through a tiny hole and returns the water pressure to the other side of the diaphragm or piston, shutting off the water. For instruction on maintenance, repair and adjustment, manufacturer's drawings and instructions are absolutely necessary. The only maintenance needed would be keeping the valve clean, especially the small opening between the two sides of the diaphragm or piston and the replacement of gaskets, washers or the diaphragm. This type of mechanism requires more water at a higher pressure than is required by flush tanks. The valve will "hang-up" and constantly trickle water and never return to a closed position, when the water pressure is inadequate. The trickling of water tends to keep the water pressure from getting high enough to shut the valves, and it might be necessary to shut stop-valves to fixture branches and allow the pressure to increase, so that branches can be turned on one at a time so that the flushometer valves will seat.

A cross-connection, in a broad sense, is any connection between a safe water supply and an unsafe or questionable water source. Avoid all direct interconnections between piping system for potable water and any piping system for non-potable water.

Vacuum breakers, backflow preventers, and siphon breakers are devices which prevent backflow into a water supply system and must be installed with any supply fixture whose outlet is submerged at any time, such as the hose and spray, direct flushing valves, and under rim water supply connections where the water surface is exposed to the atmosphere. They should be installed between the control valve and the fixtures, and at least six inches above the fixture.

Waste and Vent System. Materials for interior and exterior use vary with load conditions, space available, and corrosion expected. Cast iron soil pipe is available in several weights. It is stronger than most pipes normally used outside and must be used where traffic or heavy load producing hazards exist. Joints are usually calked with lead over oakum. Vitrified clay is the familiar red colored pipe sometimes called "Tile pipe" or "Terra Cotta." Joints are of the bell and spigot type. Some joints have preformed P.V.C. plastic tapers in both ends so that the joint is made up by coating the plastic and shoving the pipes together. Pipes that are not provided with this type joint are placed together and oakum packed around the pipe barrel to center the spigot in the bell. The rest of the joint can then be filled with cement mortar, hot poured jointing compound, and other materials. This is a good example of where proper design and installation can prevent the need for many repairs in that a sewer line using strong inert material with water-tight, root-tight, and flexible joints will not be subject to root damage, water leakage, corrosion, and erosion. Concrete pipe is the well known cement type pipe. Joints are usually bell and spigot with cement mortar over oakum. This pipe is subject to acid attack. Bituminous fiber pipe is a black, light-weight pipe that is made of paper with a bituminous impregnation and coating. Joints are tapered with special couplings. This material is subject to damage by heat and is not designed to bear structural loads. Galvanized steel can be used in conjunction with wrought or cast iron recessed drainage type fittings. Copper pipe with soldered or sweated joints has become increasingly common. Lead pipe is seldom used except for special purposes such as acid waste systems or special parts of a normal system such as closet bends, gooseneck type connections, and drum traps. Joints are normally sweated or wiped and require the services of an experienced craftsman.

Sewer lines should be kept at least fifty feet away from any water well and at least six feet from any water main. Lines passing under paved walks, and roads should be constructed with a material that will not break. Keep as far from roots as possible and be sure to use a material and type of joint which will prevent root penetration. All pipe should be supported on a firm bed for the entire length with bell holes cut as needed to keep the lines from being supported only by the bells. Backfilling should be accomplished with well tamped, thin layers of dirt, free of rocks and other materials which might result in pipe damage.

Pipe is often located in walls, between floor and ceiling or below the floor with access practically non-existent. All slip connections and unions are exposed or behind access panels. Since walls or floors may have to be cut to repair pipes, it is very important to know the exact location of all lines so that only one hole is required. All horizontal lines must be supported to prevent sagging and to maintain the proper slope. Vertical lines must be supported at the base and at other intervals as required.

Cleanouts are special pipe projections with removable caps which allow the entrance of sewer cleaning equipment into the line. Cleanouts should be provided at the base of each vertical stack, the end of each horizontal run, each change in direction greater than forty-five degrees, and at fifty foot intervals in straight lines. It is sometimes possible to clean out a line by rodding down through a vertical vent pipe through the roof or through a fixture connection after the trap is removed.

When leaks in calked or solder joints occur, recalking the lead will often stop the leak. Otherwise the joint should be remade. Remake the other type joint, if practicable; however, exterior line leakage can be stopped by completely enclosing the joint in cement grout. Broken or damaged pipe or fittings must be replaced.

The P-trap gets its name from its shape. It is used for lavatories, sinks, some urinals, drinking fountains, and most other fixtures. The trap should be protected from freezing and should have a vent pipe as required by the plumbing code. Traps of this type should have a removable cleanout plug in the bottom bend or should have a connection which allows simple removal of the trap for cleaning. Where slip type joints are used, a supply of gaskets or washers and some extra slip nuts should be kept handy. If a slip joint leaks, it would be better to remove the trap and check the threads and washer to make sure the washer seats properly because overtightening will damage the trap or slip nut. Drum traps are often used on bath tubs and on some laboratory sinks and similar type equipment. These traps are usually three to four inches in diameter, and one end is entirely removable. The removable end or cap is threaded into the body portion and the connection is sealed by a washer. The cap has either a raised lug for removal with a wrench or a recessed hole which requires a special tool for removal. Pipe wrenches should not be used on the cap since the teeth of the wrench might damage the lug. Water closets and some urinals have what are commonly called "integral traps," that is, the trap is cast as a part of the fixture and cannot be removed. Spring type cleaning rods, or "snakes," or the familiar "plumbers' friend" rubber plunger are usually used to clean these traps. When this is impossible, removal of the fixture may be necessary so that the stoppage can be approached from the sewer side of the trap. One or more water closet flange gaskets should be kept available since replacement may well be required if a fixture has to be taken up and reset and since putty and similar materials may not be used to replace the gasket.

Grease interceptors are specially designed and built units that may be bought from a manufacturer or made on the job. Their purpose is the removal and storage of grease from the waste water flow from sinks, dishwashers, and similar kitchen equipment. The grease storage capacity depends upon the design of the unit. Grease will start to pass through with the water before the top of the grease layer reaches the interceptor cover; therefore, units must be frequently cleaned of grease and sediment. This will greatly reduce sewer line stoppages and will lengthen the life span of an individual sewage disposal system.

Some laboratory waste lines are provided with tanks or basins for the purpose of diluting acid waste to help prevent corrosion of the sewer line or damage to the system or treatment works. Sometimes the size of the tank is sufficient to give a satisfactory effluent; however, where this is not true, the tank can be filled with marble chips, clam shells, oyster shells, or similar slightly soluble basic material to neutralize the acid.

The maintenance procedures listed are general in nature and manufacturers' recommendations should be followed. Manufacturers' drawings will be found useful in understanding repair and replacement procedures when such drawings are available. These can usually be obtained by writing the manufacturer.

C. ELECTRICAL APPARATUS

Relatively few school systems have a physical plant or facilities to justify a complete electrical maintenance crew. The discussion of electrical maintenance operations will be limited to the work normally done by the maintenance electrician or maintenance worker. A few remarks will be made concerning those items of electrical repair which will not customarily be handled by the campus crew or roving maintenance crew.

Primary Power Lines. Repair of damage and connecting to the high voltage lines should be left to the utility company.

Power Centers. If owned by the utility company, these power centers or transformer banks should be serviced by the company.

If the power centers or transformer banks are owned by the school system, an electrical contractor should be called to do the repair work or connections.

Switch Gear. Large physical plants will have a rather complicated switching system. Repairs to the large enclosed switches or switch panels should be left to electrical engineers and electrical contractors.

Lighting and Power-Distribution. Electrical distribution, from the power centers and switch gear, is usually accomplished in two ways. In the first case there is a system of overhead wires. In the second case there is a system of conduits or ducts. The power being distributed may be high voltage, in which case it is stepped down further by transformers in buildings or near the buildings to be served. If the power is distributed in a conduit system, the feeder lines are cables that run in underground fibre or metallic conduits encased in concrete. Any splices or junctions are generally made in man-holes or hand-holes. Every effort should be made to avoid running overhead exposed wires or cables on an elementary or secondary school campus. The overhead lines should terminate some distance away from buildings and be carried to buildings by underground conduits and ducts.

Switch Panels and Circuits. The number of lights, motors, and electrical accessories, and the power that they consume will dictate the number of circuits required in a system. Circuits are separated and fused in a metal box containing fuse blocks or breakers. Each fuse block or breaker is fused for a certain amperage. Drawing more current from the circuit than normal capacity will blow a fuse or trip the breaker.

Causes of Fuse Failure. Some of the more common causes of fuse failure are

(1) short circuits in wires, lights, or appliances; (2) overloading the circuit by having too many lights, motors, or appliances; and (3) having a fuse too weak for a circuit designed for a large number of lights and appliances.

Replacing Fuses or Resetting Breakers. Some factors which must be observed in replacing fuses or resetting breakers are as follows:

(1) Check number of lights, appliances, and extension cords for overloading. If overloading is the cause of failure, some of the load should be removed from the circuit.

(2) If fuse continues to blow or breaker continues to kick off after lightening the load, check for a short circuit in the wires, switches, or wall outlets.

(3) After the cause of the failure has been corrected, replace fuses or reset breakers.

   a. Select screw-in fuse plug or proper amperage if fuse is of the screw type and replace burned-out fuse.

   b. If the fuse is of the cartridge type, remove the end caps and check for burned-out fusible link. If the strip link is not burned in two, sand the strip ends for proper contact and replace the screw cap ends, tightening the caps properly. It is wise to use a cartridge-type fuse extractor in removing fuses. Extreme caution should be exercised.

c. Set the breaker switch to "off" position, re-set to "on" position. Should it kick to "off" position and the circuit is not overloaded or shorted out, replace the breaker block with one of proper size for the circuit. Do not replace a fifteen (15) ampere fuse with one of twenty (20) or thirty (30) amperes. This is a dangerous practice. Over-fusing will lead to burned-out appliances, shorted circuits, burned wiring, and fires.

Insufficient Capacity in the Fuse Box or Breaker Panel. When the addition of lights, appliances, and motors has used all of the circuits in a fuse box, the further addition of lights or other electric appliances will cause overloading, heating of wires, and blowing of fuses. An additional panel should be installed to provide for increased electrical consumption.

Electrical Switches and Outlets. Most troubles encountered with switches, wall outlets, and floor outlets will be a result of these units wearing out. The selection of quality switches and outlets will cut failures to a minimum. Faulty units should be replaced. The electricity should be turned off while making such replacements.

Extension Cords. Cords of various sizes and descriptions are in common use in school buildings and shops. These extension cords range from the good, heavy duty, rubber-covered type to the light and flimsy variety. It is not uncommon to see one of the light-weight cords with two or more other extensions branching out from it to serve lamps, typewriters, adding machines, and other appliances. This is a dangerous practice. First, the fine stranded wires in the cord are not designed to conduct a large supply of electricity. Second, too many appliances connected to the same outlet will overload the wires feeding the outlet. The use of extension cords should be discouraged, but if one is used to relieve a temporary need, the cord should be of the heavy, rubber-covered type.

The average light circuit is designed for a load of approximately 850 watts. Therefore, eight 100 watt bulbs would be a safe load. The addition of a floor lamp, power tool, or other electrical appliance to the same circuit would cause an overloaded condition once 850 watt consumption has been reached. The use of extension cords invites overloading and dangerous conditions.

Light Bulbs. Frequent replacement of light bulbs indicates inferior quality or trouble in the line. If good quality light bulbs continue to burn out, the circuit should be checked for bad wiring or over-fusing. The use of larger wattage bulbs than is necessary should be avoided.

Fluorescent Lamps. Care should be exercised in the electrical and lighting plans to insure that sizes and types of bulbs are cut to a minimum. Keeping many sizes and colors in stock is expensive and creates extra work. Every effort should be made to decide upon one size, type, and color. Good quality lamps should be purchased for stock purposes.

Electrical Tips. It is important that the following items be strictly adhered to with all electrical wiring and apparatus:

A. At any time electrical equipment or wiring does not function properly, it should only be repaired or replaced by a qualified electrician.

B. Over-fusing of electrical circuits is a very dangerous practice and should never be done. Each circuit is designed for a particular load. The fuse is the safety element against overloading, as is the safety valve on a boiler. If a fuse blows, it is a sign of an overload or a short in that particular circuit, and over-fusing will not correct this condition. Remove the fuse and have a qualified electrician inspect the conditions and make needed repairs.

C. The practice of using long extension cords should be prohibited. Equipment requiring extension cords comes with the proper type and length of cord, which should suffice to reach an outlet. If it does not, an additional electrical convenience outlet should be installed.

In no cases should extension cords be tacked to walls or trim, nor run through doors. All extension cords should be held to a minimum.

D. Metal terminal boxes are provided in all wiring for switches, convenience outlets, and wiring branch circuits and connections. These boxes should never be left open with exposed wiring. Covers are always provided and should be kept in place.

E. Only authorized and qualified electricians should be allowed to repair or install any wiring or electrical equipment.

F. To prevent electrical shocking and possible electrocution, the grounding of certain equipment, especially in certain locations, is a requirement of the national electrical code. It is important that this be adhered to, and if there is any doubt, a qualified electrician should be consulted.

G. Exhaust, attic, and window fans should be equipped with a heat actuated device which would disconnect the electrical current to the equipment with any abnormal rise in temperature of the air handled. Any fan which continues to operate during a fire only adds to the rapid spread of the fire.

H. Certain equipment is now supplied with highly complicated electronic controls. Whenever trouble is experienced in such equipment, qualified persons should be called for adjustments or repairs.

I. Miscellaneous

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Wire Size	Current Capacity	Proper Fuse
14	15 amperes	15 amperes
12	20 amperes	20 amperes

2. Electrical ranges and ovens should be connected with No. 10 or No. 8 wire.
3. A one horsepower motor will use 746 watts in one hour.
4. Electric buffers and sanders having a rating of over fifteen amperes should not be plugged into an ordinary convenient outlet.
5. Be careful in "skinning" wires. Stranded wires should be sharpened so as to prevent cutting through the fine wires.
6. Check for the underwriter's label.

Exit and Emergency Lighting. Exit and emergency lighting are required in all school buildings other than one story classroom buildings.

Exit lighting refers to the exit fixture installed over all required exterior exit doors and directional fixtures marked "To Exit" usually installed in corridors.

It is important, and a legal requirement, that these areas be lighted when the building is occupied and that burned out globes be replaced.

Local switches are not permitted for the control of exit and emergency fixtures. They should be controlled from one panel located in the administration section of the building.

D. HEATING, VENTILATION, AND AIR CONDITIONING

General. A school building must provide adequate shelter and protection from the elements during every school day of the year. This presupposes proper operation of heating and ventilating systems for all occasions during the season of requirement. This failure of a heating system may prove costly in a school if the school is required to close for a few days during cold weather. Proper maintenance should make it unlikely that any such closure will be necessary.

Modern school design has placed an increased reliance on mechanical ventilating and air condition systems. In many cases the design is such that the building cannot be comfortably occupied if the air conditioning or ventilating system is out-of-order for any length of time.

Hence, there is an increased awareness among school officials of the need of a maintenance program to reduce or eliminate failure of "breakdown time" in heating, ventilating, and air condition equipment.

Preventive Maintenance. Engineers and maintenance specialists, who have long wrestled with similar problems in industry, are universally in agreement that preventive maintenance procedures offer the best approach to this problem.

Just what is preventive maintenance as applied to heating, ventilating, and air conditioning equipment? Basically it can be considered a two phase system:

1. Periodic inspection to uncover conditions leading to breakdown.
2. Scheduled and systematized lubrication and cleaning including necessary procedures to correct unsatisfactory conditions.

Preventive maintenance cannot be expected to eliminate emergency or corrective maintenance. It will, however, greatly reduce emergency maintenance. Preventive maintenance will also reduce "down time" resulting from equipment breakdowns.

How can a preventive maintenance program be developed? In starting such a program, consider some of these factors:

1. Select the equipment to be included in the program.
2. Devise a record for each piece of equipment (boiler, heater unit, air conditioner, etc.) indicating the following basic information:
    (a) A complete description of the unit, manufacturer, model number, date installed, capacity and other data which will be helpful in ordering parts.
    (b) Lubrication schedule.
    (c) List of parts, inspection of which might lead to

timely replacement or repair of such items as bearings and packing glands.

3. Include a check list with the permanent record for use during inspection to record data relative to time of inspection, condition, and items needing adjustment, repair, or replacement.
4. Establish a program or schedule for utilization of the check list.

In addition, these points should be considered in the establishment of a preventive maintenance program:

1. Preventive maintenance can be overdone. Whenever the failure of a piece of equipment would not seriously hamper the operation of the school and the costs of preventive maintenance procedures are more than the replacement cost of equipment, preventive maintenance should not be considered.
2. Reduction of operation and maintenance cost may not be immediately apparent when a preventive maintenance system is established. Items reported in terms of a reduced number of breakdowns, smaller repair costs, and longer equipment life, result principally in long range savings.
3. Inspection schedules should be tailored to fit the equipment. For example, boiler interiors should be checked

annually, some bearings should be inspected weekly or daily depending on type of lubrication.

4. Preventive maintenance does not relieve the school officials of the duty of checking equipment. It does provide officials with an effective tool by which to discharge his responsibility.
5. No amount of inspection will bring results if timely and effective corrective action is not taken to cover defects.
6. Most manufacturers of mechanical equipment furnish manuals or books of instruction whenever equipment is purchased or installed. These manuals contain maintenance and operational instructions which make the best available guide for organizing preventive maintenance procedures.
7. Preventive maintenance procedures work well under either school board employee maintenance programs or contract maintenance. It is interesting to note that regular inspections provide school officials with a good control over contract maintenance costs and procedures. Inspection and proper description of defects by qualified personnel are important before calling for contract maintenance in securing effective corrective action when employing outside help on a job basis.

HEATING AND VENTILATING EQUIPMENT

School buildings are heated principally by central heating plants, unit heaters, or electric radiant panels.

Generally, central heating plants are either boiler operated systems or forced air space heaters. Boiler operational systems may be hot water or steam systems. Steam systems are classified as high pressure, low pressure, vacuum, or vapor systems. The first three types are in more common use. Low pressure steam is the system most often found in school plants.

The boilers used for school heating generally can be divided into three types: fire tube steel, water tube steel, or cast iron sectional boilers.

Fire Tube Boilers. One of the principal advantages claimed for fire tube steel boilers is ease of maintenance and inspection. The tubes can be exposed while the boiler is full of water and under pressure. This simplifies location of tube leaks and facilitates easy temporary repair of same.

Defective tubes can be replaced by specialists in a matter of a few hours provided there is space in the boiler room to perform this operation. Proper boiler room design provides space slightly greater than the length of the boiler tubes to facilitate tube pulling and replacement.

Preventive maintenance procedures for a fire tube boiler include this typical list:

Check list for inspection twice a year, once in summer (boiler not in operation) and once in winter when the boiler is in operation.

Summer inspection and procedures:

1. Drain boiler.
2. Remove manhole and hand hole covers.
3. Wash mud drum and water legs with hose.
4. Inspect boiler internally (pressure vessel engineer).
5. Clean fire tubes with wire brush.
6. Replace gaskets in manhole and hand hole covers with new ones.
7. Fill boiler and test for leaking tubes.
8. Replace leaking tubes. Retest boiler for leaks.
9. Clean combustion chamber and burners with wire brush.
10. Clean and repaint rusted areas.

Winter inspection for fire tube boilers:

1. Check for evidence of leaks.
2. Check for operation of safety devices including safety valve, low water cut-off, and flame safety devices.
3. Check for operation of valves and gauges.
4. Check for proper operation of the burner.

Water Tube Boilers. Water tube steel boilers are usually less expensive and are more compact. Tubes can be replaced easily in fire tube boilers once the tubes are exposed. The exposure of the tubes, however, involves much more time, labor, and expense necessitating the draining of the boiler and removal of the face plate. At each opening it normally is necessary to replace the gaskets.

A check list for summer inspection of water tube boiler:

1. Drain boiler.
2. Remove front and rear plates.
3. Wash out boiler.
4. Brush and clean tubes.
5. Inspect boiler and have hydrostatic test made.
6. Replace gaskets on front and rear plates.
7. Clean combustion chamber and burners with wire brush.
8. Clean and repaint rusted areas.

Winter check is the same as for the fire tube boiler. It should be noted that repairs to jackets for all steel boilers, are easily made by welding.

Cast Iron Boilers. The characteristics of cast iron in resisting rust and heat better than steel are well known. However, the cast iron sectional boiler frequently used in school heating plants presents certain peculiar maintenance problems. Cast iron is extremely difficult to weld. Therefore, temporary repairs must be made with special cements which are neither widely available nor entirely successful. The correct way to repair a cast iron boiler is to replace the defective section. This involves tearing down and rebuilding with the new section. This operation is an expensive and tedious job.

A school depending upon a cast iron boiler should take the following precautions in the event of an emergency:

1. Locate a ready source of special patching cement.
2. Locate a source of replacement sections for the boiler.
3. Establish contact with an organization capable of performing the work.

Summer preventive maintenance for cast iron boilers:

1. Carefully test and inspect boiler for leaks or other evidence of failure.
2. Remove plugs and wash out boiler.
3. Clean fire box and burners.
4. Have boiler inspected by pressure vessel engineer.
5. Replace plugs.
6. Clean and paint rusted areas.

Winter inspection can follow the same pattern as used for fire tube boilers.

Controls. Automatic control systems should be inspected and serviced at least once a year. Electronic components should be cleaned and inspected for such defects as worn relays, burned contact points, frayed wires, loose connections, and cracked insulation.

Compressed air control systems should be kept clean and free of moisture.

Boiler and burner safety devices, including controls, pilots, scanners, thermocouple leads, magnetic valves, thermostats, Basso switches, hydromotor valves, Mercoid switches, aquastats, rectifying pilots, and low water cut-off, and pressure safety valves, must be kept clean and should be checked frequently for proper operation.

Pumps. Pumps should be lubricated according to schedule. Unusual noise or vibration can indicate, among other things, malalignment, worn or poorly lubricated bearings, overload, or some other malfunction.

Motors. Motors should be kept clean, and lubrication should be scheduled according to manufacturer's instructions. A frequent check for overheating should be made in order to avoid line voltage trouble, bearing wear, or overload.

Radiators and Connectors. Radiators and piping should be painted for rustproofing. Leaks should be repaired quickly.

Fin type convectors should be cleaned at least once a year. Usually, a strong jet of compressed air and a vacuum cleaner are the most convenient and practical cleaning devices.

Central Forced Air Heating System. Central forced air heating system are essentially a ventilating system coupled with a heat source. The furnace part of the system consists of a gas or oil burner, a combustion chamber, a provision for transmitting heat from the burned gases to air, flues and stacks for getting rid of products of combustion. This distribution system consists of a fan, blower, motor, and ducts to conduct the warm air to classrooms. Thermostats are provided either to operate shutters to control the movement of air or to turn the furnace off and on.

Motors should be lubricated and checked according to schedule.

Blowers must be kept free of dust in order to assure efficient operation. Cleaning and lubricating of bearings should be done according to schedule. Drive belts should be inspected regularly and replaced when frayed or worn. Combustion chambers, stacks, and other related items must be kept tight, rust free, and in good condition to prevent entry of dangerous products of combustion into the distribution system.

Filters. Throw-away filters should be changed on schedule, according to unit manufacturer's recommendations. Usually, a filter change occurs at least once a year. Reusable type filters require frequent cleaning in order to assure good results. Electrostatic filters must be cleaned in accordance with manufacturer's recommendations. On occasions, maintenance and operational personnel may find that manufacturer's recommendation for changing or cleaning filters do not fit the conditions in certain schools. When these situations occur, maintenance personnel should determine the length of satisfactory service and schedule filter service accordingly.

Unit Heaters. Heaters of this type are usually gas fired heaters installed in a classroom. These heaters may be suspended from the ceiling or set on the floor.

What has been written about fans and blowers, motors and controls under the section on boiler and heater controls and the section on central forced air heating systems applies with regard to these heaters.

Because of the number of these units, preventive maintenance is frequently neglected. If excessive repairs and replacement are to be avoided in these unit heaters, inspecting and servicing should be scheduled at least once a year. Particular attention must be paid to inspection and proper lubrication of bearings.

Air Conditioning. It is generally expected that the trend towards more air conditioning in schools in Louisiana will continue. As a result, maintenance personnel may experience increasing problems in the care and operation of this equipment.

Generally, there are two types of air conditioners, unitary (including window or floor types) and central station systems.

All air conditioning systems consist of two components. These are the air-handling equipment and the refrigeration equipment.

Maintenance of Air Handling Equipment. Maintenance of the air handling equipment is similar to that required for warm air heating and ventilating equipment. However, there are some differences. One of the most troublesome problems experienced is concerned with excessive condensation in the air passages or at room outlet grills. This can be caused by too slow movement of air which in turn may be caused by inefficient and dirty fan assemblies, improper functioning of air intake controls, and by dirty filters.

Maintenance of the Refrigeration Part of Air Conditioning Systems. Maintenance of refrigeration equipment presents these three important requirements:

1. It should be kept clean.
2. All joints in piping should be tight.
3. Safety devices and automatic controls should be checked frequently to determine proper operation.

Watch carefully these items:

1. Proper operation of lubrication equipment.
2. Adequate supply of refrigerants.
3. Proper alignment of compressors, motors, and pumps.

Air conditioning systems should be protected from freezing during the winter by draining water from certain equipment, by adding anti-freeze to circulating water and by heating equipment rooms.

It is strongly recommended that each school having expensive air conditioning equipment employ a competent operator or engineer or see that present employees receive this type of training. Failure to do so may well result in major repairs costing many times more than the cost of providing competent personnel.

Air conditioning units should be scheduled for preventive maintenance similar to that for heating units, except that the time for major inspection, cleaning, and repairs, is during winter or cool weather rather than summer.

A typical annual preventive maintenance check list for central station air conditioning systems includes the following items:

1. Drain water tower pit, clean pit, clean strainers, and check baffles for needed repairs.
2. Clean all strainers before pumps.
3. Drain condensers and clean condenser tubes with nylon brush, hose, and water.
4. Clean cooling coils by brushing, vacuuming, or blowing with compressed air, or by using a chemical cleaning agent.

Room Air Conditioners. Annual preventive maintenance should include the following:

1. Clean or replace filters.

2. Clean coils.
3. Check for full refrigerant charge.
4. Clean drip pan and fan blades.
5. Check drive belts.
6. Lubricate.

E. HARDWARE

School building hardware, like other building components, must be maintained if it is to function properly. In many schools, much abuse, intentional or otherwise, is inflicted on building hardware. This is particularly true of door pulls, locks, door checks and closers, hinges, and panic-exit fixtures. It is not unusual to find schools in which students -- and sometimes adults -- impose terrific burdens on these items by failing to exercise common-sense precautions.

A few examples will illustrate this point: An obstruction, such as a box, a stack of books, a mop handle, or some other object placed or lodged between a door and the jamb may cause considerable damage to the door, to the hinges, or to the jamb when the door is opened. Failure to retract dead bolts or locks before doors are closed may cause damage when doors are slammed. A slight sag in a door, if not corrected, may throw strike plates or keepers and latch bolts out of alignment, and thus damage the door, the lock, and the jamb when the door is closed. Failure to use the dogging key to lock down the cross bars of panic-exit devices during the school day may cause unusual wear on these devices. Lack of door safety chains or door stops may cause outside doors, hinges, door checks and closers, and mounting brackets to be torn from moorings by strong gusts of wind. Unauthorized tampering with door closers and exposed check valves frequently causes these items to become inoperative. In addition, hold-open door hinges are often forced, thus causing breakage or damage.

In view of the hard usage usually given school building hardware, it appears that maintenance economies may be affected by (1) judicious selection of all hardware, (2) careful installation of each item, and (3) standardization of various types of hardware.

Selection. All hardware items should be selected on the basis of the functions demanded. Keep in mind that (a) each item should have sufficient weight to be durable under maximum use conditions; (b) certain types of hardware -- closers, checks, stops, hinges, and exit devices -- should have sufficient strength to accomplish the job to be done, affording controlled positive action as needed; (c) closers and checks should have key-control adjustment valves to prevent unauthorized adjustments or tampering; and (d) all hardware should be of the type that is easily accessible when maintenance is needed.

Installation. It seems axiomatic that all hardware should be properly installed. Where installation requires a mortice of any kind, this work should be done with precision so that all openings will have just enough tolerance to admit fittings without play. Screws, bolts, and fasteners should be of the right type and of sufficient size to hold such fittings securely. Templates should be used to describe positions for closers and checks, and in mounting this hardware on metal doors, and sometimes on wood or composition doors, it is advisable to use bolts that are long enough to pass through the thickness of the door and permit the installation of a metal plate on the door facing opposite the closer to eliminate the problem of screws becoming loose. Where building codes permit, double exit doors should operate to a center mullion, either stationary or demountable, for greater security for the building and for less wear on exit devices and locks.

Standardization. The use of similar types of hardware in all buildings, a form of standardization, may facilitate economical maintenance and replacement. This procedure will eliminate the necessity for large inventories for replacement parts, and will improve the skill of workers in making repairs. Locks with interchangeable cores and one control key, for example, will eliminate costly locksmith labor and time required to change locks. Furthermore, all locks to the various school building areas should be mastered-keyed for the convenience of personnel as well as the elimination of time consuming efforts. In addition to these considerations, standardization permits locks, closers, and other types of hardware to be rebuilt from salvaged parts of broken equipment at considerable savings to the school district.

F. FURNITURE

Numerous amounts and varieties of instructional equipment are needed to meet the demands of well equipped and modern educational institutions. School furniture, from the standpoint of initial cost and long-term investment, is one of the most important equipment items in an educational facility. To insure an adequate return in satisfactory service and use, it should be the concern of all responsible school officials, regardless of the size of the school or the school system, to insist that a sound preventive furniture maintenance program be inaugurated and maintained. It is important to keep in mind that the maintenance of school furniture is a vital factor in the program of instruction and that a preventive maintenance program, if properly adhered to, can reasonably insure that long periods of time will transpire before any large scale new furniture purchases will again be required. School furniture is a long term investment in which school administrators and school boards should not be required to make replacement purchases every few years. It is not unreasonable to assume that with care and periodic maintenance school furniture of good quality should render satisfactory service for an indefinite period of time.

One must consider that the kind and the amount of furniture maintenance will depend materially upon the furniture in use. In other words, the materials from which the furniture has been made and the use of the furniture are important factors to consider. Use of construction materials that are easily scarred usually require frequent sanding and refinishing.

This is an important item to keep in mind when purchasing school desks and chairs. If furniture is constructed of steel and the recently developed materials that resist marks and scratches, maintenance will be easier. Rough usage can create maintenance problems regardless of materials.

Prevention begins in the classroom because damage to desk tops and writing surfaces appears to be the most common problem facing maintenance of school furniture. School principals and teachers should insist that pupils respect desks and other school furniture so as to prevent abnormal abuse. This action would result in saving considerable time and many maintenance dollars which might be diverted to other areas.

Teachers should immediately report any maintenance or service needed in preserving school furniture. Screws and bolts should be kept tight, and glides and casters should be replaced whenever lost or worn. Minor adjustments should be made before the damage develops into major repair or replacement jobs. How much school personnel are concerned with the preventive phase in the care of furniture will determine in the final analysis the amount and the degree of repairs necessary to keep all school furniture in a satisfactory condition.

The emphasis has been placed upon the preventive phase of furniture care; however, there are three other phases to a good furniture maintenance program:

1. Recurring furniture maintenance
2. Periodic furniture maintenance
3. Replacement furniture maintenance

Recurring Furniture Maintenance. The type of maintenance that is performed in the school on one or more occasions during the year is usually referred to as recurring maintenance. This includes such items as tightening nuts and bolts, replacing glides, polishing furniture, and removal of perspiration dark spots on desks and arm chairs.

Periodic Furniture Maintenance. Maintenance occurring in certain cycles and including such items as sanding, painting, varnishing, and refinishing of furniture is usually referred to as periodic maintenance.

Replacement Furniture Maintenance. Maintenance which is concerned with repairs by the substitution of new parts for old and damaged furniture, and the necessary refinishing of such furniture is commonly referred to as replacement maintenance.

Some Considerations for a Furniture Maintenance Program

The size of a maintenance program for any school system is dependent upon many factors. Chief among these factors are such items as size of the system, volume and nature of work, repair categories, the type of equipment, and the monies available for maintenance. The furniture maintenance program likewise is dependent upon these same factors. If the school system is a small one, there is the possibility that the furniture repairs may be made within the individual school. The custodian and perhaps a carpenter may perform the work. If the school system is a large one, there is the possibility that the maintenance department for that system would do the work outside of the individual school at the maintenance department shop. There remains an additional possibility -- maintenance of furniture by contract to private individuals or companies. Whatever program is decided upon, it must be understood that before any realistic program of periodic or replacement maintenance is initiated, a thorough cost analysis should be developed which would analyize the cost of refinishing the furniture within the school. This is important. It is possible that such an analysis would show cases where it would be more practical to replace certain furniture with new furniture than to initiate repairs. Most surveys indicate that approximately eighty per cent of maintenance costs may be credited to labor costs.

When the cost analysis has been established, a decision should be reached as to what method of furniture repair will be employed. Will the furniture be repaired by a central system? Will the furniture be repaired in the school? Will the job be let on private contract?

To facilitate a cost analysis for furniture repair, it is recommended that every school maintain a continuous inventory of school furniture. The records should provide the date of purchase, cost of each unit, authorized dealers, and the name of the manufacturer. It is also recommended that each unit be marked or stenciled so that identification can be easily made.

After a system of furniture repair has been established, it is logical to develop and establish a definite cycle of furniture repair and replacement for large as well as small school systems. The cycle to function in the periodic and replacement phases must be determined by each particular school or school system. As was mentioned previously, much depends upon the type, quality, and the use of the furniture.

Some schools or school systems may find it practicable to use a ten year cycle, others may find it necessary to develop a five year cycle, while others may use an eight year cycle. The cycle would call for all furniture in a particular building to be restored, repaired, and refinished every certain number of years. Most work would be done during the summer months or during holidays. The work could be divided among crews with assigned responsibilities. Some of the larger school systems have school furniture replacement programs established in such a manner that the major amount of repairs will occur during the summer months. Refinished furniture is frequently painted a neutral or tan color which brightens classrooms.

In a small school system repairs are usually made in the school building. Any furniture which has major damage, out of necessity, must be removed to some machine shop. In the school, a systematic method should be established to facilitate the sanding, repairing, and refinishing of the furniture.

In refinishing work, the furniture should be thoroughly cleaned and sanded. In some instances, spray painting completes the job quickly and well. The tops of desks which are badly cut and marked should be covered with the recently developed plastics. Plastics provide a good writing surface, resist the natural abuse made on school furniture, and are easy to keep clean. Cost studies have shown that it is practical and economical to use plastics in the renovation of old furniture.

In laminating plastic to tables and desks the following steps are recommended:

1. Remove old varnish and surface abrasions with a portable belt sander or by hand with a block and sand paper.
2. Fill deep scars in desk tops with plastic wood, and spread an even coating of glue over the clean, sanded surface.
3. Cut plastic coverings to size with an overhand to allow for a margin of slipping when pressure is applied.
4. Place the plastic in proper position in order to insure even distribution of pressure over the entire surface.
5. Vary setting time according to the type of glue used.
6. Trim, sand, and lacquer the edges.

The most frequent repair to furniture is the repair of glides. Each individual school should be supplied with an ample supply of the type required for school furniture. Repairs could be made immediately before damage is sustained by the floors.

Mention has been made on several occasions on the extent and frequency of furniture repair. Usually, repairs depend upon the care, use, and quality of construction. When making new furniture purchases, school officials and board members should seriously consider these qualities:

1. Conducive to good posture.

2. Proportioned for comfort.
3. Conducive to proper light reflection.
4. Strong and light in weight.
5. Well constructed.
6. Attractive in appearance.
7. Resistant to scuff.
8. Easy to maintain and repair.
9. Properly oxy-acetylene-welded.
10. Standardized for parts replacement.
11. Best in quality and workmanship.

CHAPTER IV

FIRE PREVENTION AND SAFETY

Fire prevention and safety are two problems of great concern to school administrators. The former conserves property, saves lives, and forestalls suffering; the latter seeks to prevent accidents, particularly accidents causing disablement, dismemberment, and death.

There are numerous significant factors directly concerned with developing and assuring a sound program of fire prevention and safety. Some of the more important concerns as recommended by the office of the State Fire Marshal are emphasized in this phase of the report.

Exits. The rapid and complete evacuation of a building is of paramount importance. Adequate exits and exit-ways are mandatory requirements. At no time should these facilities be blocked by furniture or other items, nor locked in such a manner that ready egress would be impeded. Chains and padlocks should never be used to lock any occupied rooms or areas or doors in exit-ways or exit doors. Required exterior exit doors are provided with fire exit bolts (panic hardware). This hardware should at all times be kept in proper operating condition. No doors to occupied rooms and areas should be equipped with hardware of a type which when locked would prevent egress from the room or area. All required exit doors and doors in exit-ways should swing in the direction of egress.

Stairs. All fire codes usually require stairs to be enclosed in fire partitions and self-closing fire doors. In addition, it is necessary and vital that ground floor passage to the exterior be direct or through a protected area. Furniture, drinking fountains, and other equipment should not be installed in stair enclosures, on platforms, or in any manner which would impede passage. Hand rails must be installed on both sides of the stair case, and excessively wide stairs should be provided with an intermediate hand rail. A non-slip surface is desirable on all stairs and platforms. Proper illumination must be maintained whenever the building is occupied. Storage closets under stairs are prohibited. All stair enclosures should be provided with ventilation at the top in order to remove smoke. Due to the highly functional use of stairs in schools it is at times desirable to keep the fire doors open. If the doors are held open, it should only be done by a suitable low temperature fusible link located at or near the top of the door, and never by the use of hooks, floor chocks, or heavy objects placed on the floor. It is not recommended that fire doors be held open. Exterior stairs are highly desirable, however, the doors to the stairs must be equipped with fire exit bolts. Fire escapes are not approved for new construction.

Fire Escapes. Fire escapes, when required as an additional emergency means of escape from existing buildings, should comply with the following conditions:

1. The rise and run shall be similar to that required for interior stairs.
2. The width of the escape and platforms shall be in proportion to the number of persons who would probably use the escape and in no case less than thirty-six inches wide.
3. Hand rails shall be provided on both sides.
4. Access must be through an out opening door equipped with fire exit bolts.
5. Counterweighted lower sections are not permitted. All fire escapes should be periodically examined for necessary repairs.
6. Escapes should be kept well painted.
7. Wooden fire escapes are not recommended.
8. Slide and other patented means of escape are not approved.

Trapped Area. Dead ends or trapped rooms and areas are defined as rooms or areas from which a person can go in only one direction to an exit door on the ground floor or a stair enclosure on other floors. The distance along the normal line of travel measured from the end of the building to the above mentioned exits should in no case exceed forty feet.

Wall Finishes. Combustible interior wall and ceiling finishes such as wood paneling, plywood, fiber boards, and wood wainscots should be held to a minimum. However, whenever these materials are used it is recommended that application be made directly to gypsum plaster or sheet rock backing and not directly to wood stud or combustible framing.

Draperies and Decorations. Draperies, curtains, stage curtains, scenery, Christmas and Hallowe'en decorations should be of flame-proof type. These materials should be kept at a minimum. This type of material should never be installed near to heaters, stoves, electric motors, and other mechanical equipment. Temporary combustible decorations should be removed from the building as soon as practicable and should never be stored in the building unless in close covered metal containers. Combustible material should never be stored in closets under stairs, mechanical equipment rooms, and similar areas.

Storage of Highly Combustible Items. Flammable material and supplies, such as floor oil, cleaning fluids, kerosene, gasoline, alcohol, paint, paint thinners, oils, mops, brooms, and rags, should not be stored in the school building. Provisions for a suitable storage building or a fire-proof storage room must be made.

Floor Oil. In order to avoid dust, many wood floors in schools have been treated with floor oil. This practice causes the wood to become heavily oil soaked and highly combustible. This practice should not be allowed. New wood floors may be varnished and waxed. Old floors should be scrubbed and sanded to remove excess oil.

Waste Paper and Trash. Waste paper and other trash should be collected daily from all areas of the building. This material must be disposed of at frequent intervals, either by burning in an approved incinerator or by hauling away from the school building. If such materials are stored, metal cans with tight metal covers should be used.

Mechanical Equipment Rooms. It is a legal requirement that all mechanical equipment subject to explosion must be located in a room or area separated from the remainder of the building by fire walls and interior fire doors.

If one of the walls in a school building must be an exterior wall, it is suggested that adequate windows glazed with thin glass be used. This type of construction would act as a relief valve and blow out in the event of an explosion. Openings to the exterior must be provided for ventilation and combustion air. Gravity roof ventilators are recommended. It is preferable that there be no interior doors to these rooms or areas and that access to them be through exterior doors. Rooms as described in this part should not be adjacent to exits or stairs. Combustible material should never be stored in mechanical equipment rooms.

Gas Fired Equipment and Piping. All gas-fired apparatus, except stoves, ovens, hot plates, and bunsen burners should be equipped with safety pilots and automatic controls and vented to the exterior with an approved vent. Cooking equipment in kitchens should be installed under an approved type of metal hood with an exhaust fan. This hood should be equipped with grease filters or grease traps which must be replaced or cleaned at frequent intervals.

Gas is a dangerous fuel, and all gas piping should be installed in exposed and occupied areas so that any leak would be readily detected. The gas piping system should be periodically checked for seals. Gas piping should not be installed under buildings, in unventilated attics or walls, or between floors. Each gas terminal should be fitted with a shut off valve in addition to the valve on the equipment. The main cut-off valve should be located on the exterior in a visible and readily accessible location. The operating personnel should be informed of this location and instructed to cut the supply of gas in any emergency. Wherever possible, connections to equipment should be made with rigid pipe. Flexible rubber tubing is strictly prohibited, and soft flexible copper piping is not recommended for any permanent installation.

Fire Extinguishers. State law requires that in all buildings not less than one approved type of hand-operated fire extinguisher be provided for each 2500 square feet of gross floor area. It is advisable that additional extinguishers be provided in kitchens, mechanical equipment rooms, woodworking shops, and other similar hazardous areas. The type of extinguisher utilized is important, and a bulletin can be obtained from the office of the State Fire Marshal describing different methods of operating various types of extinguishers. Some fire extinguishers require periodic recharging. It is advisable that a member of the school staff be assigned the task of maintaining extinguishers on an immediate use basis.

Extinguishers should be placed in conspicuous places and not hidden in closets. In some areas it is desirable to install automatic sprinklers.

Fire Alarms. It is necessary that all schools conduct periodic fire drills. In order to accomplish this objective, a fire alarm is necessary. This system must be separate from all other signaling systems, and the alarm must be audible to all occupants of the building. The system should be supervised and maintained in a proper working order ready for use in any emergency. Rapid evacuation of schools is imperative, and one fire drill should be held during each school month. No advance notice to pupils or personnel should be made. It is desirable to block off certain exits simulating a fire in that area in order that the general procedure would not become stereotyped.

There are other items of extreme importance in the development of a sound fire prevention and safety program, however, the more important factors have been presented.

CHAPTER V

THE CENTRALIZED SCHOOL SERVICE CENTER

A centralized school service may be defined as the central control and administration of maintenance, operation, warehousing, transportation, and lunchroom supplies for all the schools of a school system. The purpose is to assure efficient and economical operation for all branches of the system. This type of program is designed to enable school maintenance personnel in different positions to serve the children in the schools under the best possible conditions.

A frequent question concerned with a centralized school service program is, which schools should have a central system. Many volumes have been written on this single question, and the most practical approach to the problem appears to center around the size of the system and the location of the various schools operated by the administrative unit. Several different variations in each area will at times determine whether a central service will be of economical value to the school system.

Attention should be given to three of the most important objectives of a centralized service center:

1. To provide the proper services and supplies needed to keep the present school plants in satisfactory condition in order that the instruction and operation may be effective and without undue interruption.

2. To survey constantly the school property and to determine when old buildings, equipment, and practices are out-dated and should be replaced.
3. To transport pupils, supplies, equipment, and food, in order that teachers, pupils, and other school employees may perform a more effective job.

In school systems with less than ten schools, the problem of whether to maintain a central supply system for the whole area is one which requires considerable attention. In many administrative units, the cost of such a program may be prohibitive and impractical.

In the larger school systems with more than twenty buildings, a centralized system of serving schools may be necessary. Listed here are a few of the advantages derived from this type of operation:

1. All purchases are made by an experienced person and each school is assured of receiving the best quality products in properly allocated amounts. This insures quality supplies in all schools with even stock distribution.
2. Lower prices are usually quoted when products are purchased in large quantities and delivered to one location.
3. Better inspection and testing is accomplished when materials are delivered to one area.
4. Stock items may be arranged in neat order and inventory cards may be maintained on an up-to-date basis.

5. Sources of information concerning school business are available to school administrators to alleviate certain problems.
6. A central service assists in attracting and retaining competent personnel. Specialization may be possible in many departments.
7. A central service permits a better and more complete use of equipment and labor. The proper utilization of skilled and unskilled labor can be more easily accomplished in a centralized service.
8. In-service training may be accomplished with better results in a central service area. Employees are able to practice improved techniques and safety can be stressed and observed.
9. Emergency services may be rendered more effectively and economically when the proper services, parts, and equipment are available and stocked.

Despite the numerous advantages of a centralized service program, some disadvantages do exist. Consideration should be given to the most frequently experienced ones:

1. A danger may be extreme over-specialization. Experts are inclined to direct their efforts to limited areas and to neglect the interests of the whole organization.
2. Departments may become engrossed in serving personal needs and ignore cooperation with other agencies.
3. If specific instructions and definitions of the various jobs are incomplete, a waste of labor and loss of morale will follow.

The centralized school service should be under the parish superintendent, business administration office, and supervisors of the different service departments. The smaller school systems must depend more upon the ability of a few people to maintain and operate the wide range of equipment and supplies needed in a present day school system. There is no substitute in any sized system for an intelligent and experienced employee who takes pride in keeping the school plants, supplies, and mechanical equipment in good operating condition.

In recent years, maintenance, operation, and planning of the schools have become progressively more complex. For this reason the employees selected for the different departments must be intelligent and diligent, and must possess a wide knowledge of school practices.

Whenever possible and feasible, it is better to locate or center all services of the school system in one area. Generally found in a school service center are these services or divisions:

I. Maintenance.
    A. Surveys, estimates, plans for repairs and alterations.
    B. The operation of shops to care for the different types of mechanical equipment in the schools:
        (1) Carpenter or cabinet work.
        (2) Heating.
        (3) Refrigeration.
        (4) Electricity and electronics.
        (5) Plumbing.

        (6) Painting.
        (7) Glazing.
        (8) Hardware (locks, checks, closers, hinges).
        (9) Grass, grounds, and outside equipment.
        (10) Record keeping and accounting necessary for maintenance and maintenance supplies.
        (11) Maintenance of trucks, busses, and automobiles.

II. Plant operation.
    A. Requisitions for services and supplies.
    B. Supervision and instruction of custodial service, cleaning, fire prevention, and care of equipment.
    C. Directions for the proper care of the building, equipment, and grounds.

III. General store services.
    A. Warehousing for quantity purchases.
        (1) Cafeteria food and equipment.
        (2) School supplies.
        (3) Textbooks.
        (4) Maintenance materials, parts, and special tools.
    B. Bookkeeping and perpetual inventory for store keeping.
    C. Handling of requisitions.
    D. Receiving goods and checking orders.

E. Delivery of supplies to the schools.

(1) Central mail and memorandums.

(2) Maintenance and operating supplies.

(3) Instructional supplies and equipment.

(4) Cafeteria supplies and equipment.

(5) Storage and transfer of used materials and equipment.

(6) Storage and disposal of obsolete and worn out equipment.

Many school systems have converted vacant school buildings into central service facilities. Although the old building will not serve as well as a new and well-planned building, it usually can be utilized to a great extent if all of the departments can be located in one area.

In school systems in which enrollments are constantly increasing and no other type building is available for use as a central service center, steel buildings may be utilized. Above all, adequate space should be provided for all areas. Facilities should be arranged to load and unload supplies and heavy equipment with speed and safety.

In organizing a central system, plans should be formulated far in advance for the location of the following large and essential services:

1. Carpenter and cabinet shops in which bulky loads must be handled.
2. Refrigeration necessary for perishable goods for the cafeterias.

3. Gasoline tanks, pumps, vents, washing, greasing, and servicing areas for trucks.
4. Heavy material storage areas and equipment for handling cartons to the best advantage.
5. Sufficient space, or additional space on future construction, to store equipment, supplies, and materials for delivery to the schools, and additional space to store equipment brought in for repairs.
6. Facilities for classification and perpetual inventory for small and numerous items needed in all departments.
7. Use of maximum rated, fire-resistant materials in construction.

CHAPTER VI

SUMMARY

A guide for school administrators and maintenance personnel has been prepared in terms of standardized procedures and techniques utilized in preserving, protecting, and keeping buildings, grounds, and equipment in a satisfactory operating condition.

Four major topics, namely, maintenance of exterior facilities, maintenance of interior facilities, fire prevention and safety, and centralized school service centers have been included in the report.

Grouped as exterior facilities were such items as school grounds, building foundations, walls and ceilings, fenestration, and roofs. Meanwhile, such items as floors, plumbing systems, electrical apparatus, heat and air conditioning, hardware, and furniture were classified as interior facilities. Detailed information relative to maintenance of each of these items has been presented.

It was recognized that fire prevention and safety are two problems of great concern to school administrators. An effort was made to present detailed information relative to the numerous significant factors concerned with the development of sound programs of fire prevention and safety.

It was evident that increased interest and attention will be devoted by school administrators to the establishment of centralized school service centers. These centers may be organized in any parish or city system irrespective of the size of the unit. Hence, materials concerned with this phase of the program were considered important and vital in a school maintenance guide.

Efforts were directed toward providing certain acceptable and standardized maintenance procedures and techniques, which were applicable and necessary in the development of a satisfactorily operating maintenance program. Too, it was recognized that evaluations of the school maintenance program should be made at periodic intervals. Improved techniques and practices, which result in a more economical and efficient school maintenance program, usually follow these evaluations.

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